W. B. Herms

ANNUAL REPORT

OF THE

COLUMBUS HORTICULTURAL SOCIETY

FOR THE

YEAR ENDING DECEMBER 31, 1906

COMPRISING

THE CONSTITUTION OF THE SOCIETY, LIST OF MEMBERS, OFFICERS AND PROCEEDINGS OF THE MEETINGS, TOGETHER WITH PAPERS AND DISCUSSIONS

EDITED BY

JAS. S. HINE.

SECRETARY

COLUMBUS, OHIO:
PUBLISHED BY THE SOCIETY
1907

Columbus Horticultural Society

1906

OFFICERS

WILLIAM R. LAZENBY ..... *President*
HERBERT OSBORN ..... *Vice-President*
JAS. S. HINE ..... *Secretary*
GEO. W. SINKS ..... *Treasurer*

EXECUTIVE COMMITTEE

GEORGE W. GILL — J. WARREN SMITH
S. C. DERBY

CHAIRMEN OF STANDING COMMITTEES

J. H. LAGEMANN ..... *Botany*
VERNON H. DAVIS ..... *Vegetable Pathology*
HERBERT OSBORN ..... *Entomology*
J. WARREN SMITH ..... *Meteorology*
T. A. SCOTT ..... *Fruits*
H. WARREN PHELPS ..... *Vegetables*
GEO. W. GILL ..... *Forestry*
S. C. DERBY ..... *Library*
O. E. JENNINGS ..... *Plants and Flowers*

MEMBERS

LIFE

ALDRICH, DR. O. W.....11 Wesley Block, Columbus
BRADFORD, MRS. JOSEPH.....29 S. Garfield Avenue, Columbus
BRENNEMAN, MRS. J. H.....1355 E Main Street, Columbus
BRUNNING, MRS. H. D.....768 Oak Street, Columbus
CRAWFORD, MATTHEW.....Cuyahoga Falls
DESHLER, WM. G.....Columbus
DEVOL, W. S.....Riverside, California
FARNSWORTH, W. W.....Waterville
GREEN, W. J.....Experiment Station, Wooster
HARDY, C. J.....46 S. Sixth Street, Columbus
HARRISON, J. J.....Painesville
LAGEMANN, J. H.....356 Miller Avenue, Columbus
LAZENBY, PROF. W. R...Horticultural Hall, O. S. U., Columbus
LOFLAND, MRS. P. J.....984 East Long Street, Columbus
LOVEJOY, MRS. N. E.....805 East Broad Street, Columbus
MILLER, WM. .....Gypsum
PUGH, JOHN M.....1074 East Broad Street, Columbus
RODGERS, A. D.....632 East Broad Street, Columbus
SCOTT, T. A.....Westerville
SESSIONS, H. M.....1256 Eastwood Avenue, Columbus
SINKS, GEORGE W.....714 East Broad Street, Columbus
VERGON, F. P.....Delaware

ACTIVE

ALSPACH, CLINTON.....Camp Chase
BOARDMAN, J. D.....Worthington
BOGUE, E. E.....Agricultural College, Michigan
COTTON, E. C.....Experiment Station, Knoxville, Tennessee
DAVIS, V. H.....Horticultural Hall, O. S. U., Columbus
DAVIS, A. S.....Worthington
DETMERS, MISS FREDA.....1315 Neil Avenue, Columbus
DERBY, PROF. SAMUEL C.....93 Fifteenth Avenue, Columbus
DETWILER, DANIEL.....Canal Winchester

DICKEY, C. L. ..... Worthington
DILL, F. P. ..... Westerville
DITTO, T. W. ..... Delphos
EVERAL, J. W. ..... Westerville
GAYMAN, MISS ELIZA ..... Canal Winchester
GILL, GEORGE W. ..... 287 East Broad Street, Columbus
HINE, JAMES S. ..... Ohio State University, Columbus
HOLT, S. R. ..... Worthington
JENNINGS, OTTO E. ..... Carnegie Museum, Pittsburg, Pa.
KNOPF, ALBERT ..... 1351 Fair Avenue, Columbus
LEHMAN, ISAAC ..... Canal Winchester
MCFADDEN, PROF. L. H. ..... Westerville
MILLS, W. C. ..... Orton Hall, O. S. U., Columbus
OSBORN, PROF. HERBERT ..... Ohio State University, Columbus
PHELPS, H. WARREN ..... 88 Pugh Avenue, Columbus
PHINNEY, MRS. T. O. ..... Clintonville
PRICE, PROF. H. C. ..... Townshend Hall, O. S. U., Columbus
ROWND, R. M. ..... 52 Jefferson Avenue, Columbus
SELBY, A. D. ..... Experiment Station, Wooster
SCHOTT, S. ..... Lancaster
SHARP, C. E. ..... Westerville
SHARP, MRS. C. E. ..... Westerville
SPAHR, GEORGE T. ..... 621 East Town Street, Columbus
SPERRY, F. P. ..... 41 Martin Avenue, Columbus
SMITH, J. WARREN ..... Weather Bureau, Columbus
SUTTON, L. K. ..... 113 South Fourth Street, Columbus
TUSSING, R. J. ..... Canal Winchester
THORNE, PROF. C. E. ..... Experiment Station, Wooster
VIVIAN, ALFRED ..... Townshend Hall, O. S. U., Columbus
WARREN, E. G. ..... Hilliards
WEBSTER, PROF. F. M. ..... Dept. of Agriculture, Washington, D. C.
WERNER, W. C. ..... Painesville
WETHERELL, J. ..... Camp Chase
WHITNEY, DR. W. C. ..... Westerville

CONSTITUTION

NAME AND OBJECT.

SECTION 1. This Society shall be known as the COLUMBUS HORTICULTURAL SOCIETY.

SEC. 2. The object for which it is organized is the advancement of horticultural knowledge.

MEMBERSHIP.

SEC. 3. Any person may become a member of the Society by the payment of one dollar. Wives and daughters of members shall be members without the payment of any fee. Male members shall pay an annual fee of fifty cents, in advance, which shall be for the year ending with the next succeeding annual meeting; and no member shall have the right to vote, or other privileges of membership of the Society so long as such annual fee shall remain unpaid. Any lady resident in Franklin County may become a member without any fee.

SEC. 4. Any person may become a life member of the Society upon payment of ten (10) dollars, which shall be in lieu of all assessments or annual dues; and all persons who have been members for twenty or more years and have paid their regular dues, shall be life members.

SEC. 5. Any person distinguished in horticulture, upon the recommendation of the Executive Committee, may be elected an honorary member of the Society by the affirmative vote of two-thirds of the members present at any regular meeting. Honorary members shall not have the right to vote nor incur any of the liabilities of members, but they shall be admitted to all meetings and exhibitions of the Society.

OFFICERS.

SEC. 6. The officers of the Society shall be a President, Vice-President, Secretary, Treasurer and an Executive Com-

mittee of three members, all of whom shall be elected by ballot at the annual meeting in December, and shall serve until their successors are elected.

SEC. 7. The President, or, in his absence, the Vice-President, shall preside at all meetings of the Society and of the Executive Committee. In the absence of both, a President *pro tem.* shall be appointed.

SEC. 8. The Secretary shall keep a record of the proceedings of the Society, edit the same for publication, prepare a suitable program for each regular meeting, and attend to all necessary correspondence. He shall also collect all moneys due to Society for membership, annual fees and assessments, and pay over the same to the Treasurer; and shall receive as a remuneration for his service five dollars ($5.00) for each meeting.

SEC. 9. The Treasurer shall receive from the Secretary all moneys and funds belonging to the Society, and shall be the custodian of all bonds, stocks and securities belonging to the Society, and shall pay out and transfer the same only on the order of the Society, certified by the President and Secretary; and he shall keep an account of the receipts and disbursements, and report it to the annual meeting; and shall give such bonds as the Executive Committee may require.

SEC. 10. The Executive Committee, including the President and Secretary *ex officio,* shall have control of all exhibitions, and have a general supervision of all matters pertaining to the welfare of the Society. It shall have power to call special meetings whenever, in its judgment, it shall be necessary.

SEC. 11. The chairmen of the standing committees shall be elected at the annual meeting, and such chairmen shall have the power to appoint the other members of their respective committees.

SEC. 12. The following standing committees shall be elected:

1. On Botany.
2. On Vegetable Pathology.
3. On Entomology.
4. On Meteorology.

5. On Library.
6. On Fruits.
7. On Plants and Flowers.
8. On Vegetables.
9. On Forestry.

Investments.

Sec. 13. The Executive Committee shall make and manage all investments. No investment shall ever be changed without the recommendation of said committee, approved by two-thirds each of the members and life members of the Society; nor shall the present invested fund of the Society ever be reduced in amount; but if it should become so by any unavoidable cause, the income shall be invested until the full amount is restored.

Sec. 14. The funds of the Society shall be invested in the bonds of the United States, the State of Ohio, the City of Columbus, or Franklin County, Ohio; or in loans at not exceeding the legal rate of interest in the State of Ohio, payable semi-annually or annually, and secured by first mortgage on unencumbered real estate, situated in Franklin County, Ohio, of the value of twice the amount of the sums loaned thereon, provided that all buildings standing on such property shall be fully insured during the term of the mortgage.

Amendments.

Sec. 15. This Constitution may be amended at any regular meeting of the Society by a two-thirds vote of the members present: Provided, due notice of such proposed amendment shall have been given at least one week before such meeting.

BY-LAWS

Order of Business.

Section 1. The following shall be the order of business at every meeting, unless changed at the time by the vote of the meeting:

1. Reading the minutes of the preceding meeting.
2. Unfinished business.
3. Election of members.
4. Reports of special committees.
5. Reports of standing committees.
6. Communications and correspondence.
7. Regular papers or addresses and discussion.
8. Miscellaneous business.
9. Adjournment.

Time of Meeting.

Sec. 2. Regular meetings shall be held some time during June, October and December, the exact date to be fixed by the Executive Committee. The meeting in December shall be the annual business meeting.

Columbus Horticultural Society

APRIL MEETING.

A meeting of the Society was held in Horticultural Hall, at the Ohio State University, on April 27, 1906.

As the Secretary, Mr. E. C. Cotton, had taken a position in another State, and wished to be relieved of the Secretaryship, Jas. S. Hine was selected to fill out the unexpired term.

It was voted to give the Treasurer permission to sell the Hocking Valley Railroad Bonds and invest the money at a higher rate of interest, if possible.

In order to make it possible for the Treasurer to lend money on first mortgage on Franklin County real estate, it was voted to make the following change in the Constitution of the Society:

In Section 14, lines 7 and 8, the clause "exclusive of buildings and improvements" was dropped and "provided that all buildings standing on such property shall be fully insured during the term of the mortgage" substituted.

The regular program consisted of a paper by Prof. Alfred Vivian, on "Planting a Home Town-lot," and one by R. A. Young, entitled: "Tree Planting."

JUNE MEETING.

A meeting of the Society was held in Horticultural Hall, June 9, 1906.

Professor Lazenby exhibited a device for picking cherries. It consisted of a pair of scissors to which a small bag was attached. When the cherries were clipped off with the scissors, they fell into the sack. The device is known under the name of Start's Cherry Picker, and is manufactured in Columbus.

Prof. Lazenby also exhibited specimens to show the effect of tieing strings around growing trees and allowing them to remain.

The regular program consisted of the following papers:

"Cover Crops for Orchards," N. E. Shaw.

"Chemical Composition of Different Varities of Grapes," E. I. Lichti.

"Notes on Ohio Mosquitoes," Wm. E. Evans, Jr.

"Willow Insects," R. D. Harned.

Mr. G. W. Gill gave a formula for preparing an ointment which he recommended for mosquito bites and Rhus poisoning. It consists of five per cent. fluid extract of benzoin in lanolin or oil of wool.

OCTOBER MEETING.

The Society accepted an invitation from Mr. F. P. Vergon, of Delaware, to hold a field meeting on his grounds, Saturday, October 13, 1906.

Several members attended this meeting and pronounced it a most enjoyable occasion. Mr. Vergon has a well kept apple orchard and a drive through it at picking time is most interesting. The orchard remains in sod from year to year, but is regularly mowed, and the crop used as mulch for the trees. These are trimmed so low that a man may stand on the ground and pick the majority of fruit from fifteen year old trees.

The method of picking and sorting the fruit and the packing houses, attracted the attention of members as did the fine appearance of the orchard and its product.

The finest kind of Rambo apples and plenty of fine sweet cider were furnished by Mr. Vergon and wife, and all present were urged to indulge to the utmost.

Those present expressed a desire that the hosteses be extended a vote of thanks for their hospitality.

DECEMBER MEETING.

The annual meeting of the Society was held in Horticultural Hall, on Saturday, December 29, 1906.

Professor Lazenby reported that H. P. Lentz, a member of the Society, had died during November, and that Prof. John Haywood, of Westerville, died at his home on December 12th, at

the age of 81 years. He also read a letter from Prof. J. H. Lagemann, in which the writer expressed regret at not being able to attend the annual meeting on account of poor health. Prof. Lagemann sent his report on botany, however, and it was read by the President. This report appears in print on another page of the Journal.

Prof. J. Warren Smith reported on Meteorology for the year. His report appears below. In addition to the written report, Prof. Smith commented upon the use of telephones in distributing weather forecasts. The large number of telephones now in rural homes make it possible to reach a large percentage of the farmers very promptly. A great deal of interest is manifested and much benefit derived. He stated that he is going to make an effort to have horticultural workers make more use of frost warnings.

L. K. Sutton stated that fruit picked before the freeze of October 10th, is keeping better than that picked since that time.

Professor Lazenby stated the report had come to hand that many apples had rotted in Missouri.

Mr. Sutton stated that barrels and cars were scarce, and for that reason much of the fruit produced could not be marketed.

H. Warren Phelps read a report on Vegetables. This report appears in full on another page.

The Treasurer's report was read and ordered printed after approval by the Auditing Committee, consisting of Geo. W. Gill and Prof. S. C. Derby. Prof. S. C. Derby moved that $200.00 additional of the Society's money be invested, thus raising the investments up to $6,000.00. Carried.

Election of officers for the ensuing year resulted in naming the old officers, in every case, for another term.

Professor J. H. Lagemann was tendered a vote of thanks for faithful attendance and interest in the Society. The hope was expressed that he may soon recover from his present illness and be able to attend many more meetings.

Professor Lazenby stated that a plan was on foot to have a general meeting of United States Horticulturists at Jamestown, in August, next year.

JAS. S. HINE,
Secretary.

Climatological Review of the Year, 1906.

PROF. J. WARREN SMITH.

January, 1906, was the warmest January since the establishment of the Ohio State weather service, in 1883, except in 1890, The temperature was higher at many stations than has ever before been recorded during the winter months. The month was unusual also, in the fact that the lowest temperatures were recorded in the southern part of the State instead of the northern counties. The snowfall was light in the north, but was moderately heavy in the south.

February gave about the usual temperature, but the precipitation was very deficient. A very heavy snow fell in some of the north-eastern counties on the night of the 4th, and in the extreme south, on the 27th.

March was the coldest on record for the State, except in 1885. The snowfall was unusually heavy between the 11th and 20th.

April was unusually warm. The precipitation was the lowest for the State for this month, on record, with two exceptions. Snow fell in northern counties on the 5th and 23rd.

There has been but one May, since 1883, with a less rainfall than was recorded for the State during this month. Killing frosts were general on the 10th, and occurred at a number of places in northern counties on the 28th and 29th. Snow fell in the north on the 9th.

A light frost was reported, in northern counties, on June 12th, and at Orangeville, in the north-east, on June 24th. The rainfall for this month was unevenly distributed.

July was cooler than the normal and the rainfall was above the normal. The month was characterized by heavy local storms. Damage by lightning was unusually great.

August was warmer than usual, and had more rainfall than the normal for the month. A number of observers reported the wettest August on record. There were heavy, unevenly dis-

tributed showers. An unusual number of barns were burned by lightning and several people were killed.

September was considerably warmer than the normal. A light frost was reported in a few places on the 15th and 24th.

In October, a few observers in the north-eastern portion of the State, reported a frost on the 8th, but generally the first frost of the season came with freezing weather, on the night of the 10th. Snow fell in most of the State on the 10th, and came before frost damage. In much of the State this was the earliest snow on record and at some stations, the first time that snow has fallen before a frost.

General snow fell during the second decade of November. Some damage was done by high winds on the 21st. At Toledo the wind reached a velocity of 68 miles an hour, and at Columbus of 56 miles an hour, on that date.

For the State the average temperature was 3.3° above the normal during the winter months (Dec. 1905 and Jan. and Feb. 1906); 0.8° below the normal during the spring months; 0.5° above the normal in the summer, and 0.9° above the normal during the fall. For the year from December, 1905, to November, 1906, inclusive, there were three months, only, colder than the normal and nine months warmer. For the year the temperature averaged 0.8°, a day warmer than the normal.

The precipitation was less than the normal, during the winter and spring, and above the normal in the summer and autumn. It was less than the normal during 7 of the 12 months and greater during five. For the year, the average fall for the State was 1.40 inches less than the normal amount.

Annual Report of the Committee on Vegetable Pathology.

VERNON H. DAVIS.

While last season was one of unusual rainfall, several of the more common plant diseases did not become as serious as conditions warranted us to expect. This seemed to be noticeably true of the apple scab. While some scab was to be found in almost every locality, some few orchards came to our attention that produced almost perfect apples without spraying. This should not be taken as an excuse for not spraying another year, or any year, any more than the fact that your house did not burn down should be taken as an excuse for cancelling the insurance. Spraying should be looked upon as an insurance from year to year. True, in some season when conditions are just right, good crops may be secured without it, yet it is impossible for us to foretell what the conditions are going to be. Again, some disease may be present in such small quantities that little harm may be done to the growing crop, yet plentiful enough to prepare the way for total destruction another year.

The asparagus rust was not so abundant as usual, and did little or no damage on the University grounds. The Palmeto variety still continued to demonstrate its value as a rust resisting sort. It is not entirely rust proof with us, but while other varieties are usually dead before September 1st, the Palmetto always remains green until cut or killed by freezing.

One of the most troublesome diseases of our gardens during the last few years, has been one attacking carrots, usually about the middle of July. In 1903 our crop was a failure, on soil that had been growing carrots for several years, sometimes alternating with other crops. In 1904, five acres were planted on soil that had not grown carrots before, and a little more than 11 tons per acre were harvested. The same land was planted in 1905, a portion of the area receiving a heavy application of stable manure, but the greater portion of it receiving none. The stand secured

was perfect and the growth, during the first part of the season, was all that could be desired. About the middle of July, however, blight began to appear, and only about 12 tons were harvested from the entire area. Very little, if any difference could be seen in the manured and unmanured portions. In 1906 carrots were again planted on the soil that grew them in 1903, after having been heavily manured. It was thought that the two years rest would be sufficient to starve out the disease, but the crop was again almost a total failure. The first symptoms are a withering and dying of the older leaves which continues as fast as new ones are formed, leaving only a small tuft of foliage for the manufacture of plant food. The crown sometimes decays and the roots keep very poorly in storage. The large amount of labor required to start the crop makes a failure a very expensive one. On the other hand, a good crop means a handsome profit. The roots are sold entirely as stock food.

Our muskmelons were sprayed three times with bordeaux which protected the vines from the blight until well into the ripening season. The plants finally succumbed to the disease and the loss was less than 1/4 the crop. The difficulty in covering all the under side of all the leaves with the spray mixture, makes it almost impossible to completely control this disease, nevertheless spraying is usually sufficiently successful to make it quite profitable.

Annual Report of the Committee on Botany.

PROFESSOR J. H. LAGEMANN.

Members of the Society:

You know that I have always been willing to do my best to raise the standard of our Society, but now, I am sorry to say, I am no longer able to fill my place as Chairman of the Committee on Botany, since my health has given out. Therefore I wish you would choose a stronger man in my place.

Looking backward over the past years, I feel somewhat discouraged when I see that many of our favored plans show little hope of being realized. Concerning our streets, I like to see more hardy shade trees planted where weakly ones have given away on account of being much damaged, to allow room for electric wires and the like. It seems that it would be well to plant more Elm, Tulip, Sycamore, and Oak. Our parks also need more replanting. The American Olive, in Schiller's Park, has died and should be replaced. Franklin Park needs some planting of our beautiful American shrubs.

I often recommended shelter plantations for outhouses and corners in our parks, and would now suggest, that, in the Capitol grounds, the bare rear of the McKinley Monument, be obscured with such shrubs as the American Holly, Spice bushes, Dogwood and Black Haw, and it would be well to plant similar shrubs on some of the corners in the same grounds.

We should have a wash house like other cities of the old and new world, where they are found an absolute necessity. It seems that it costs a great deal more to build such buildings in Columbus than in other Cities. It is most discouraging when we see that a park manager cuts down ornamental spruce and pine trees, which it took a life time to grow, and has nothing better to replace them, than some unnatural, uncanny boxes for our too much petted squirrels. But what can we expect of our city that is too poor to turn a little drinking water for man and beast into the well known fountain on the corner of High and Broad Streets, and to let the people enjoy a refreshing drink at the new McKinley Monument?

Gentlemen I am through and wish my successor to follow energetically in my steps.

Annual Report of the Committee on Fruits.

H. WARREN PHELPS.

The season has been a most remarkable one for the growth of vegetation: "The farmers generally have said that the season was the greatest that was ever known in Ohio, for the growth of all vegetation for reason of the many and frequent rainfalls. But for the same reason there was much loss in the matured crops of hay, wheat and oats."

The loss in vegetation was very light from either rot or waste, on account of the frequent rainfalls or great heat of the sun. During the latter part of the month of July, there was rot in potatoes in some of the clay and black soils: it, however, was not extensive in either territory; nor period of time. The hot sunshine, after the copious rainfalls, caused tremendous growths of all kinds of vegetables, the wet and heat both being condusive to rapid growth. There did not seem to be any diseases or fungous growths to injure any vegetable. Weeds grew rapidly, but where the hoe was used with energy, they did no harm.

The only reason that there could be any complaint of high prices for any vegetable, is that gardeners and farmers do not plant and cultivate a large enough area in vegetables, to supply the ever growing demand in the towns and cities, which are rapidly increasing in population, while the farms are losing in population.

Farmers who study, carefully, the great changes which are going on; the change from country to town, and city; and who take advantage of such changes, are not anxious nor willing to part with their lands; nor to exchange occupations.

There has been a general good quality in vegetables, owing to the fine preparation of the soil, and good cultivation.

Tomatoes did not set well, the heavy rainfalls washed the bloom away. Wherever pumpkin and squash seed was planted, and the plants were well cared for, the crop yield was very good. Potatoes have kept well so far.

There is a large crop yield of cabbage.

GEO. W. SINKS, TREASURER, IN ACCOUNT WITH THE COLUMBUS HORTICULTURAL SOCIETY.

RECEIPTS.

1905.	
December 21, to balance	$493 73
1906.	
February 1, to interest on H. V. Ry. bonds	100 00
March 21, to interest on turnpike bonds	15 00
September 20, to interest on H. V. Ry. bonds	100 00
September 21, to interest on turnpike bonds	15 00
November 13, to interest on U. S. 3% bonds	9 00
December 24, to amount received for dues	12 00
	$744 73
1906.	
December 24, to balance	$450 53

DISBURSEMENTS.

1905.	
December 20, by paid V. H. Davis, Secretary	$30 10
1906.	
March 14, by paid Wm. R. Lazenby	23 25
March 14, by paid The M. C. Lilley Co	6 75
April 6, by paid The Bucher Engraving Co	7 25
April 9, by paid Ethel S. Dean	2 60
April 25, by paid Cherington Printing and Engraving Co	2 50
July 19, by paid Berlin Printing Co	186 75
July 20, by paid V. H. Davis	7 00
December 24, by paid J. S. Hine, Secretary	28 00
Balance	450 53
	$744 73

INVESTMENTS.

U. S. 3% bonds	$300 00
Franklin Co. Turnpike 6% bonds	500 00
Hocking Valley Ry. 4% bonds	5,000 00
Total	$5,800 00

Respectfully submitted, Columbus, Ohio, December 24th, 1906.

G. W. SINKS, *Treasurer.*

COLUMBUS, OHIO, February 11, 1907.

I have this day examined the books and accounts of Geo. W. Sinks, Treasurer, for the year 1906, and find that they agree with his statement above submitted.

GEO. W. GILL,
Chairm. Committee.

IN MEMORIAM.

PROF. JOHN HAYWOOD.

Prof. John Haywood was born in Stockton, Chautauqua County, N. Y., March 16, 1825, and died in Westerville, Ohio, Dec. 12, 1906, aged 81 years, 8 months, and 26 days. He was the sixth in a family of ten children of whom he was the last survivor. He was united in marriage with Miss Sylvia Carpenter, in 1852. To this union were born six children, of whom Mrs. L. O. Miller, of Dayton, Ohio, is the only survivor. His wife, Sylvia, died in 1886, and in 1888 he was united in marriage with Miss Eliza Carpenter, a sister of his previous wife, who survives him.

In preparing this brief memoir, it is pleasant to feel that there need be no restraint, but instead, the utmost freedom and abandon. Nothing needs to be suppressed, nothing glossed over, lest kindred and friends be offended or pained. The life of Professor Haywood was an open book, filled from cover to cover with good reading, not a page or line of which needs to be omitted, lest harm be done. The only perplexity, in the brief time available, is to make a proper selection from the wealth of material at hand.

Mr. Haywood began his personal education in a log schoolhouse, so common in his day. Later he attended a village school of higher grade, and so diligently did he apply himself, that when, in 1845, at the age of 20, he went to the Oberlin Collegiate Institute, as it was then called, he was able to gain freshman standing in one year. We get here an early prophecy of the man and of his subsequent honorable and useful career, in the fact that in his deep poverty, he aspired to a college education, and resolved to attain it. Oberlin college commended itself to him be-

cause he had been told that expenses were less than in other colleges, and that a student would have opportunity to defray part or all the expenses of the course with the proceeds of manual labor. These conditions seemed to open the way for a young man without money, but willing to pay the cost by hard labor, to secure a college education, and he resolved to travel that way.

Mr. Haywood graduated from Oberlin in the class of 1850, consisting of twelve members, of which, his death, leaves but two survivors. At his graduation, he had not decided upon a vocation for life. His inclinations were to surveying, but no opening presented itself, and his poverty rendered it imperative that he secure some remunerative employment as soon as possible. An opportunity to teach school at Seville, Medina County, was presented, and he promptly accepted it.

In 1851, a vacancy occurred in the factulty of Otterbein University. Mr. Haywood was selected to fill the vacancy. He began his labors at Otterbein University, on the 19th of March, 1851. Thus he began his career as member of the faculty of Otterbein University, which, excluding an interval of five years, from 1862 to 1867, was destined to continue actively for a period of 37 years. The entire period of his membership in the faculty, extended a little over 50 years, which is the record period of Otterbein University at this date.

While he always considered his service in Otterbein University as his great life work, he found time for many outside duties. He took a prominent part in the incorporation of the village of Westerville, and was its first mayor. As a member of the council and as the village surveyor or engineer, his connection with local public affairs continued until recent years, so that a large part of the village history is closely connected with Prof. Haywood's service in its behalf.

He began, on his own responsibility, 40 or 50 years ago, systematic observations of rain fall, temperature, etc. Later, with standard instruments, he made daily records in the Voluntary Service of the Weather Bureau. In this he was as faithful and pains taking as in regular professional duties. He continued these observations until perhaps three years ago, when increasing

infirmities induced him, though reluctantly, to give them up. The one instrumental observation he continued almost to the day of his death, though it had, years ago, ceased to be important, was that of time with the Sextant. Though cut off by impaired hearing with easy intercourse with his fellows, he always manifested the liveliest interest in current scientific progress and indicated, by his questions and comments, that by reading, he was keeping pretty fully abreast with the times.

He joined the Columbus Horticultural Society in 1893 and retained his membership until his death, being in attendance at meetings whenever conditions would allow. He was always an interested listener and often took part in discussions.

Professor Haywood, in his religious life, as in all things, was modest and unobtrusive, but thoroughly faithful and reliable, and his religious influence in the church, in the university, and in the community, was ever wholesome and good. But he has gone. He now rests from his labors and his works follow him, in the thousands of laborers, once his students, scattered in every part of this country, and in far away countries, in Asia and Africa. We, who remain, can in no way better honor his memory than by emulating his example and by doing what we can to promote the interests of the noble institution he loved so well, and served so long, and by consecrating ourselves anew to the service of the Redeemer, whom, through a long life, it was his great delight to serve.

The Comparative Value of Orchard Cover Crops.*

NORMAN EWING SHAW.

The value of cover crop in cultivated orchards is no longer doubted by commercial orchardists. It is only a question of what crop would be most advantageous to use, and would best suit

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certain conditions. Great variations have been found to exist with different crops in the results which they produce, and this experiment was undertaken to determine the value of different crops in securing some of these results. The larger part of the work pertains to the effect of the crops on the moisture content and temperature of the soil. Aside from these main features and results directly due to them, careful observations have been made on the depth of freezing, ability to hold snows, rate of growth, and a source of humus to the soil.

In regard to the value of the crops in taking up soluble salts or as a gatherer of nitrogen from the atmosphere (as in the case of legumes) nothing was done.

The crops used in the experiment were carefully chosen with respect to their adaptability to this locality, and covers practically all classes of crops used for this purpose. Great care was taken in taking all samples, reading and measurements; yet it is probable that some errors may have occurred.

The writer wishes to thank Professor Davis under whom the work was conducted, for many valuable suggestions and favors, and also Professor McCall, for the kindly loan of instruments used in the experiments.

CONDITIONS AND METHODS.

The experiment proper was begun in August, 1904, and continued until May 15th, 1906. The ground chosen for the experiment is located on the University farm, in a pear orchard of ten years' growth. The soil is classed as an upland loam, and lies in the second river bottom. This soil had received uniform treatment for several years preceding the beginning of the experiment in the application of manure, cultivation and crops grown upon it.

During the summer of 1904, a crop of early potatoes was grown upon this land, and these were removed about the middle of July. The ground was then thoroughly cultivated, disked and harrowed, and all weeds removed.

The experiment consisted of nine rows of pear trees, each

row constituting a plot and contained one-tenth of an acre of land. The plots were very uniform in the character of soil, and general contour, having a slight dip to the west. Eight different cover crops were used, one crop being planted in each tree row. One row was given clean culture for comparison. The crops used, were as follows:

Plot No. 1, Cow Peas,
Plot No. 2, Canadian Field Peas,
Plot No. 3, Hairy Vetch,
Plot No. 4, Dwarf Essex Rape,
Plot No. 5, Clean Culture,
Plot No. 6, Oats,
Plot No. 7, Corn,
Plot No. 8, Rye,
Plot No. 9, Buckwheat.

(In the charts and tables the crops are frequently referred to by numbers as given above.)

In making the moisture determinations, a soil sampler (such as is in use by the Bureau of Soils at Washington) was used. Samples were taken at irregular intervals of the first and second foot of soil, two samples being taken for each depth from different parts of each plot, and placed together, for the moisture determination.

This was done in order to get a fair average. These samples were placed in tin boxes and the lids then screwed on tightly to prevent a loss of moisture. Samples were then carefully weighed, placed in an oven as 110°C and dried until a constant weight was reached. The moisture content was then found, and the percentage of moisture was figured to the dry weight of each sample so that accurate comparison might be made.

The soil temperatures of the different plots were found by the electrical method, a temperature coil being placed in each plot. These coils are about six inches in length, and where placed in a verticle position, extending from twelve to eighteen inches below the surface. In this way the temperature of the six inches of soil was taken just below the surface foot. This was thought to be a proper depth as it would ordinarily be below frozen ground,

and yet near enough to the surface to show the effects of the different crops on the temperature of the soil. The insulated wires from these coils extended above the surface and were easily attached to the electrical thermometor when readings were made. These readings were made at irregular intervals, and whenever there was any change in condition that could in any way effect the results.

OBSERVATIONS ON MOISTURE.

First Year.

The crops were sown on the 10th of August. A drill was used as the soil was very dry at the time, and in this way the seed was planted evenly and much deeper than would have been possible by sowing broadcast. On August 14th, .04 of an inch of water fell, and the plants came through rapidly. By the 20th of the month, the crops were all up, and most of them had covered the ground.

Referring to Table II., it will be seen that from August 19-22nd there was a period of rainfall aggregating .92 of an inch. On the 23rd samples of soil were taken, and the results show unusually high percentages of moisture, but with variations among the different plots. (See Table I, August 23rd.) These figures show the value of a cover crop in holding the water giving it an opportunity to soak into the ground instead of allowing it to run off of the surface. Plots No. 5 and 8 contain far less moisture than any other plots. The rye was much slower in starting than the other crops, and offered practically no covering to the ground at the time these samples were taken, and this probably accounts for its low amount of moisture in comparison with the other crops.

August 27th. Heavy rains occurred on the evening of the 25th, and samples, taken on August 27th, show practically the same results as those taken on the 23rd. There is a much less percentage of moisture, however, as the water has a much longer time in which to pass away than on the 23rd, when the samples were taken a few hours after the rain ceased. The clean culture

and rye plots contain from 1 to 5 per cent. less moisture than the other plots. It is true that they probably contain less moisture before the rain, but with a rainfall of 1.15 inches (See Table II) this difference was largely overcome.

Sept. 12th. With favorable rains and an average temperature of about 70°, the crops had made a wonderful growth by this time. Sixteen days had elapsed since the preceding samples were taken, and the figures show the effect of growing crops in taking moisture from the soil and robbing the trees of its supply. This can be seen by referring to Table I, also Chart I. The clean culture plot shows the least per cent. of loss. This is due to the fact that its loss of moisture was only from evaporation, while other plots suffer an additional loss through the agency of the crop and transpiration. The loss by evaporation from covered plots is very small as they are protected from the drying effects of sun and wind. Plots 4 and 6 show the greatest losses. The remaining ones do not vary to any marked degree. Rape is very succulent, and while it shades the ground very thoroughly, the loss of moisture, by transpiration, is very great.

September 17th. By September the field peas were entirely killed by green aphis and Plot 2 was practically barren. The moisture table shows it to have lost less moisture than any other plot. For some days previous to the total destruction of this crop, it was so weakened by the aphis that practically no growth was being made, and consequently little moisture was being taken from the soil, and what remained of the crop, retarded evaporation from the surface.

Plot 5 still shows a smaller loss than the covered plots. Plots 9, 7 and 3 now lead respectively in the amount of moisture lost. The Rape plot, however, shows a lower per cent. at this date than any other.

September 24th. Samples taken on this date, show less variations in the percentage of moisture. However, the differences in the amounts lost by the different plots since the preceding samples were taken, is very marked. Plots 2 and 5 have lost from 4 to 7 per cent. more moisture than covered plots. Here evaporation from the uncovered plots has been greater than transpira-

tion from the covered ones. The nights were quite cool at this time and very slight frosts occurred, consequently growth was not nearly so rapid as it had been.

The days were very warm as a glance at the temperature tables will show, and evaporation was undoubtedly taking place very rapidly.

This accounts for the great loss of moisture in Plots 2 and 5. Chart I has been prepared from the moisture table to show the comparative losses of moisture in the different Plots between dates on which samples were taken.

Beginning with August 27th, the total dark and light portions represent the amounts of moisture present on that date. The dark lines show the amount of moisture on September 12th, and the light shaded lines the amounts of moisture lost by the different plots between these two dates. It will be seen that for this period, while the crops are very small, that more moisture is being lost from Plot 5 which is uncovered than from covered plots. In the middle section of the Chart, the total dark and light portions show the amount of moisture on September 12th, and the dark shaded parts show the amounts contained at the next date of sampling, on September 17th. The light shaded portions shows the relative amount of moisture lost between the two periods of sampling. The crops, at this time, have made a good growth and the Chart shows that the covered plots are now taking more moisture from the soil than the barren ones. Plot 2 now corresponds to Plot 5 since the field peas were entirely destroyed by the aphis. In the lower section of the Chart, the light shaded portions show the amounts of moisture lost from September 17th to 24th. Here growth had ceased to such an extent, that the crops were taking but very little moisture from the soil. The barren plots show a much greater loss of moisture than covered plots. Vetch and rye which are hardier than other crops, were making some growth and have removed more moisture than other crops.

This period, from August 27th to September 24th, represents the most active period of growth, and clearly demonstrates the value of a crop in taking moisture from the trees at this time,

thereby hastening its maturity and lessening the danger of winter killing.

On September 29th, the first killing frost occurred, and cow peas, corn and buckwheat, were killed, while vetch, rape, oats and rye, were uninjured, and continued to grow. Through October the position of the plots in relation to their moisture content, gradually changes. At the beginning of the month, Plots 2 and 5 (the barren ones) contained the highest per cent. of moisture. This is the cause until after the 16th, when they are surpassed by those plots on which the crops have been killed by frost; while those plots having crops which are still growing, have dropped below all other plots in the amounts of moisture which they contain. This results from the fact that they are still taking moisture from the soil, while those killed, are no longer doing so, but are acting as a mulch for its conservation. The moisture averages, for October, very clearly show these results.

During the month of November, in which there was but .13 of an inch of rainfall, the plots occupied practically the same relation in regard to moisture content, as at the close of October. Plot 4 being the lowest with 12.50 per cent. of moisture, 2.50 per cent. lower than any other plot. The ground was frozen during most of December, January and February, and but one sample was taken for each month. Their results are unimportant, as the frozen ground would largely prevent the movement of waters, either to or from the ground. For the samples taken December 2nd, there are great differences in the moisture contents. They range from 11.65 per cent. to 18.61 per cent.

January 3rd. The ground was frozen to a depth of several inches at this time. Samples taken, show but small variations. Plot 6 is lower than other plots, the low average results from a loss of moisture in the second foot, which is unaccounted for. The same is true for samples taken February 7th, where the moisture content of the second foot, bears the same relation as in the preceeding samples of January 3rd.

With the beginning of March, the frost had practically all left the ground. Occasionally a slight crust would be formed at night on exposed plots. Determinations made March 11th, show

the clean culture plot to contain less moisture than other plots which has largely been from a loss in the second foot. This may be due to alternate freezing and thawing and evaporation. Plot 2, however, which is uncovered, does not correspond in this respect. Plot 4 still remains low in the amount of moisture which it contains, not having overcome the great loss caused by transpiration during the growing period.

The next samples were taken April 3rd. Vetch and rye survived the winter, and during the latter part of March began to grow. Rye started somewhat earlier than vetch. The determinations for this date shows Plots 1, 3 and 8 to contain the least amounts of moisture. Through their roots, vetch and rye are now rapidly taking moisture from the soil, this accounting for their low percentage. The danger of allowing them to grow too long, at this period, is very apparent. In Plot I, the loss from the second foot is unaccounted for. Other plots are very similar in their moisture content.

The last samples of the season were taken on April 15th. Plots 3 and 8 are still lowest in the amounts of moisture which they contain. However, Plots 2 and 5, which are barren, have lost more rapidly, by evaporation, at this time, than these growing plots. Plots 1 and 4 should not be compared with these, because of probable inaccuracies in the second foot of the preceding samples.

This completes the samples taken for these crops, during the first year. Averages for the year show Plots 4, 5 and 8 to have contained less moisture than other plots. These differences are not great and are of little importance for a single season.

TABLE I.

SHOWING MOISTURE PERCENTAGE OF SOIL FOR FIRST YEAR, AND AVERAGE OF 1ST 2D FOOT.

Date.	Plots.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
August 23 —									
1st ft.	112.80	96.15	143.59	103.27	77.61	86.36	96.77	84.74	103.33
2nd ft.	84.90	74.62	83.92	77.61	59.17	143.60	146.34	47.91	61.72
Average	98.85	85.38	113.75	90.44	68.39	114.98	121.55	66.32	82.52
August 27 —									
1st ft.	49.07	40.82	39.82	51.44	41.11	55.38	47.22	41.01	49.18
2nd ft.	36.58	37.70	44.09	41.77	35.43	46.72	39.84	31.02	43.28
Average	42.82	39.26	41.95	46.27	38.28	51.05	43.53	36.01	46.21
September 12 —									
1st ft.	28.00	29.36	32.20	35.87	32.45	28.36	33.91	24.54	40.95
2nd ft.	30.35	32.36	34.30	22.45	35.23	30.09	36.22	29.60	33.33
Average	29.17	30.86	33.35	29.16	33.84	29.22	35.06	27.07	37.14
September 17 —									
1st ft.	13.24	26.72	13.03	12.42	26.26	18.14	13.65	12.94	10.47
2nd ft.	16.88	18.88	20.28	16.29	18.53	15.86	20.22	18.62	19.58
Average	15.01	22.80	16.65	14.35	22.39	14.50	16.93	15.78	15.52
September 24 —									
1st ft.	14.04	11.73	11.68	117.11	15.81	12.42	13.59	11.80	11.35
2nd ft.	15.52	19.09	19.62	15.09	15.80	14.32	18.18	12.97	16.06
Average	14.78	15.41	15.65	13.40	15.80	13.37	16.38	12.38	13.70
October 1 —									
1st ft.	12.50	14.85	11.52	14.37	16.35	12.23	13.98	12.57	11.39
2nd ft.	17.36	17.98	16.40	16.86	17.96	15.84	18.34	15.68	15.32
Average	14.93	16.44	13.96	15.61	17.15	14.03	16.16	14.12	13.35

TABLE I — Concluded.

SHOWING MOISTURE PERCENTAGE OF SOIL FOR FIRST YEAR, AND AVERAGE OF 1ST 2D FOOT — Concluded.

Date.	Plots.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
October 12 —									
1st ft.	15.38	18.12	15.63	14.14	19.09	14.36	18.55	16.61	14.38
2nd ft.	16.41	16.19	17.66	18.54	16.51	16.19	16.71	15.43	16.00
Average	15.89	17.15	16.64	16.84	17.80	15.63	16.63	16.02	15.19
October 26 —									
1st ft.	16.22	15.47	12.70	11.57	15.91	15.46	17.01	14.98	16.48
2nd ft.	17.82	16.48	14.28	16.13	17.97	12.72	17.52	15.35	17.39
Average	17.02	15.94	13.49	13.85	16.94	14.09	17.26	15.16	16.94
November 2 —									
1st ft.	14.32	14.80	12.00	12.21	15.33	14.62	16.66	12.46	14.71
2nd ft.	17.58	15.34	17.42	14.92	16.88	16.14	18.18	16.66	21.44
Average	10.95	15.07	14.71	13.56	16.08	15.38	17.42	14.56	18.07
November 16 —									
1st ft.	13.45	16.78	12.57	7.69	13.08	13.71	16.10	13.63	12.91
2nd ft.	16.62	20.25	19.51	15.18	20.90	13.75	19.82	18.20	19.54
Average	15.03	18.51	16.04	11.43	16.99	13.73	17.96	15.91	15.72
December 2 —									
1st ft.	17.09	16.04	12.83	11.85	13.11	10.88	17.07	10.24	12.35
2nd ft.	11.88	21.19	19.09	15.88	21.16	16.48	16.28	18.75	21.31
Average	14.48	18.61	15.96	13.86	13.13	13.68	11.65	14.46	16.83
January 3 —									
1st ft.	32.17	26.44	28.19	31.42	28.67	26.45	26.79	25.87	25.75
2nd ft.	20.83	24.24	24 41	22.41	22.99	15.92	24.33	22.10	24.17
Average	26.50	25.34	26.30	26.91	25.83	21.18	25.56	23.98	24.96

February 7 —									
1st ft.	36.26	32.89	29.61	25.69	30.71	27.37	32.53	29.02	30.36
2nd ft.	18.28	20.28	20.48	19.94	22.22	16.35	20.62	20.48	19.44
Average	27.27	26.58	25.04	22.81	26.46	21.86	26.57	24.75	24.90
March 11 —									
1st ft.	30.20	30.31	30.07	22.79	24.41	29.12	30.35	32.72	26.40
2nd ft.	18.65	21.39	22.35	23.51	15.01	20.56	22.14	18.55	23.07
Average	24.42	25.85	26.21	23.15	19.71	24.84	26.24	25.63	24.73
April 3 —									
1st ft.	11.32	10.35	10.23	11.50	9.81	11.68	10.50	9.45	10.52
2nd ft.	8.60	12.00	9.82	19.75	15.01	12.79	14.03	6.03	13.39
Average	9.96	11.17	10.02	10.60	12.41	12.23	12.26	7.74	11.95
April 15 —									
1st ft.	11.11	10.75	10.03	12.46	10.09	12.65	14.69	9.27	13.13
2nd ft.	10.88	12.16	11.36	10.85	11.35	12.54	9.42	10.69	11.21
Average	10.99	11.45	10.64	11.65	10.72	12.59	12.05	9.98	12.17

TABLE II.

DAILY PRECIPITATION FOR FIRST YEAR.

Date.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
1	.48	.22							
2		.03				.07			
3			.03			.05			.09
4									.01
5			.15			.01	.30		
6						.21			
7								.46	.34
8				.02			.28	.85	
9			.05			.05	.17		
10			.06	.10	.23				.60
11			.23			.42			.14
12			.58			.18	.52		
13							.01	.03	
14	.64								
15									
16									
17					.33				
18		.03						.11	
19	.28				.01			.15	
20	.23								.55
21	.06		.08					.21	.83
22	.35		.01			.04			
23					.12	.02		.04	
24		.25	.18		.80	.02			
25				.01	.65	.02	.19		
26	1.50	.08			.74				.44

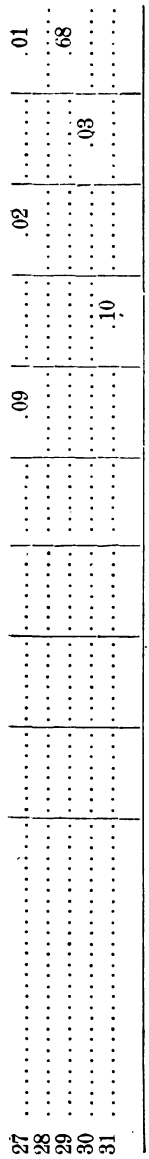
.01
.68
.03
.02
.10
.09
27
28
29
30
31

TABLE III.

SHOWING TEMPERATURE OF PLOTS FOR 1ST YEAR AND MEAN DAILY TEMPERATURE OF AIR.

Date.	Plots.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	Mean D. Temp.
Date.										
October 8	55.0	56.5	54.5	55.0	56.0	55.5	55.5	56.5	56.0	61.33
October 10	60.0	60.0	60.5	59.0	60.5	59.5	59.0	61.5	61.0	71.66
October 29	46.0	46.0	47.0	45.5	46.0	47.5	46.5	46.5	46.0	43.33
November 9	45.5	45.5	46.5	45.5	45.0	46.0	46.0	46.5	45.5	43.66
November 14	40.0	40.5	42.5	42.5	41.0	42.5	42.5	42.0	41.5	37.00
November 16	39.5	40.0	42.0	42.0	41.5	42.0	42.0	41.5	41.0	41.66
December 5	36.0	37.0	35.5	38.5	37.5	38.5	39.0	38.5	38.5	29.33
December 24	38.0	39.5	40.0	38.5	38.5	39.0	40.0	40.0	39.0	32.00
December 28	39.0	39.0	40.5	40.0	41.0	42.0	41.0	41.5	40.0	13.00
January 4	34.5	34.5	36.0	35.5	35.0	37.0	36.0	36.0	35.5	15.66
January 6	35.0	35.0	36.0	35.5	35.0	35.5	36.0	36.0	36.0	33.33
January 12	33.0	33.0	34.0	34.0	35.0	35.5	35.0	34.5	34.5	34.33
January 16	32.5	32.5	34.0	33.5	32.0	34.0	33.5	32.5	33.5	20.66
January 23	32.0	32.0	33.5	33.0	33.5	33.5	33.5	32.5	33.0	22.66
February 1	30.5	32.5	32.5	32.0	30.0	32.5	32.5	31.0	32.5	17.33
February 6	30.0	30.0	31.5	30.0	30.0	31.0	31.0	31.0	31.0	17.66
February 14	30.0	30.0	31.5	30.0	29.5	31.0	31.0	30.0	30.5	7.66
February 24	30.0	30.0	31.5	31.0	29.5	32.0	31.0	30.0	30.0	33.66

March 3	31.0	31.0	32.0	31.0	30.0	32.0	31.0	31.0	31.0	38.66
March 9	31.0	31.0	32.0	31.0	31.0	32.5	32.0	31.0	31.5	33.33
March 16	32.0	32.0	33.5	32.0	31.5	33.5	32.0	32.0	32.0	50.00
March 24	40.5	40.5	42.0	41.0	40.0	42.0	42.0	41.0	41.0	49.66
March 27	48.0	48.0	46.5	47.0	48.5	47.0	48.0	47.0	47.5	60.33
April 4	50.0	50.0	48.0	49.0	50.0	49.0	50.0	49.0	49.5	51.00
April 6	39.5	39.5	41.0	41.0	40.0	41.5	40.5	41.0	41.0	37.00
April 13	45.0	45.0	43.0	44.0	45.0	43.5	44.5	43.0	45.0	57.00
April 21	47.5	47.0	48.5	48.0	47.0	48.5	48.0	48.5	48.0	53.00
April 22	50.0	50.0	48.0	48.5	49.0	48.0	48.0	48.0	49.0	48.00
April 25	45.0	45.0	42.5	44.5	45.0	43.0	44.0	42.5	45.0	59.66
May 13	50.0	50.0	47.5	47.5	49.5	48.0	48.0	47.5	50.0	62.00

TABLE IV.

MEAN DAILY TEMPERATURE FOR FIRST YEAR.

Date.	1905. Aug.	Sept.	Oct.	Nov.	Dec.	1906. Jan.	Feb.	Mar.	Apr.
1	76.33	76.00	62.33	48.33	38.00	47.33	17.33	34.66	57.33
2	70.33	76.00	61.66	54.00	32.33	40.66	—1.00	29.00	55.00
3	69.33	72.33	48.66	48.66	29.66	19.33	6.33	38.66	58.00
4	75.00	64.66	58.00	49.66	28.66	15.66	8.00	32.66	51.00
5	75.33	67.00	63.00	45.00	29.33	30.00	17.66	36.33	44.00
6	76.00	68.00	49.66	37.66	28.33	33.33	17.66	36.66	37.00
7	72.33	69.00	51.00	46.00	33.00	23.33	6.00	39.66	34.33
8	67.00	67.00	61.33	43.33	36.66	17.00	22.66	32.66	42.00
9	74.33	67.33	72.66	43.66	29.66	24.66	33.66	33.33	61.66
10	73.00	69.66	71.66	40.66	20.00	7.33	15.00	33.00	66.00
11	72 00	76.33	64.00	33.66	16.33	32.66	17.33	34.33	50.00
12	73.00	57.66	53.66	36.33	24.33	34.33	31.00	32.33	48.66
13	80.33	67.66	50.66	32.00	19.00	26.33	.66	31.66	57.00
14	72.00	60.00	50.66	37.00	12.66	16.33	7.66	31.00	47.00
15	69.60	55.00	50.00	39.00	13.33	13.00	2.66	37.66	39.66
16	74.00	62.33	50.66	41.66	18.00	20.66	14.66	50.00	34.33
17	74.66	70.66	56.66	44.33	29.66	27.00	25.00	56.00	41.33
18	63.33	66.00	59.33	48.33	24.00	36.00	19.00	59.33	39.33
19	69.33	66.00	62.33	46.00	26.66	36.33	28.66	58.33	51.66
20	75.66	63.00	62.66	56.66	30.00	33.00	36.00	41.66	58.66
21	76.66	54.66	48.66	43.66	24.00	33.00	34.33	36.66	53.00
22	74.33	53.00	43.00	42.66	33.66	23.33	35.33	41.66	48.00
23	66.66	67.00	42.00	42.66	49.33	22.66	32.33	57.00	52.00
24	69.33	70.33	52.00	41.33	32.00	19.00	33,66	49.66	58,66

25	78.00	69.00	44.66	34.66	35.33	10.66	35.33	55.00	59.66
26	63.00	72.66	41.33	31.33	44.33	12.33	33.00	54.33	59.00
27	64.66	70.33	39.00	26.00	50.33	24.66	29.66	60.33	60.66
28	67.33	70.00	42.66	31.00	13.00	14.66	37.33	64.00	65.66
29	69.00	79.33	45.33	51.00	19.66	11.33	....	70.00	61.66
30	71.66	66.00	44.33	26.00	35.33	13.33	....	50.00	54.00
31	73.66	....	42.00	....	41.66	23.00	....	54.66	....

OBSERVATIONS ON MOISTURE.

Second Year.

From the middle of May when the crops of the first season were plowed under, the orchard was kept under cultivation until the crops were again sowed. The method followed was to stir the ground after each rain, using both cultivator and smoothing harrow. If weeds appeared, the cultivator was used, otherwise the surface was broken by means of the harrow only. On July 13th, the plots were thoroughly cultivated, disked both ways, and harrowed. This placed the soil in excellent condition, and planting was done by means of a drill on July 15th. The same crops were used in the same plots as in the preceding year, with the exception of Plot 1, where soy beans were substituted for cow peas. In order that the crops might have a longer period of growth, and to allow them to make a more efficient cover, they were sown twenty-six days earlier than the year before.

In comparing the results of the second season with those of the first, some differences may be expected. The fact that the crops were sown earlier the second year, was advantageous to some, while harmful to others. Oats which made a wonderful and excellent cover, thefirst season, gave opposite results for the second.

In this longer growing period, conditions were favorable for the development of rust, which attacked this crop and largely checked its growth. This was also true of rye, to a small extent. Field peas and buckwheat were not benefited very much by the earlier planting. On the other hand, soy beans, vetch, rape and corn, made a larger growth and more effective cover. A comparison of the precipitation, Tables VII and VIII will show a great difference in the amount of rainfall for the two growing periods, and this effect will be noted in the comparison to follow. By the 19th of July, the ground was becoming dry, and the plots were rolled with a tubular roller, in order to press the soil more firmly about the seed and to hasten sprouting. Two small showers aided germation somewhat, and by the 24th, all crops were up. Growth was rather slow until August 6th, when 1.15

inches of rain fell. The first samples of soil were taken July 19th, before any crop had appeared. By referring to Table V, and noting the moisture averages for this date, it will be seen that the different plots are very similar in the amounts of moisture which they contain, the greatest difference being but 1.01 per cent. This establishes, very clearly, the uniformity of the plots in the character of the soil and general contour.

The next samples were taken on August 26th; the crops had been growing about one month, and the determinations made at this time should correspond, in some respect, to those made September 12th, of the preceding season, when about one months' growth had also taken place. The samples of August 26th show as great differences as those of September 12th, but they do not show exactly the same differences. The clean culture plot, instead of containing the largest amount of moisture, which was true the first season, on the corresponding date, now contains the lowest per cent. Table VI shows that for the period from July 19th (when the growth began) to August 26th, there was a rainfall of 5.37 inches, which occurred at intervals of from three to five days. A hard crust was formed on Plot 5, and in this way, a large amount of the water ran from the surface during the rains, while conditions were also favorable for rapid evaporation. On the other hand, the covered plots were conducting practically all the water of each rain into the soil, and the loss from transpiration was much less in this case than by the evaporation of the barren plot. During a like period of growth, the preceding season, when precipitation was not so copious, the reverse was the case. The most rapid growers consisting of soy beans, rape, oats, corn and buckwheat, have, next to the barren plot, removed the most moisture from the soil, which was true the preceding season, while field peas, vetch and rye, have lost the least amount.

On September 19th, samples were taken after a series of rains, which aggregated 2.39 inches (See Table VI). The clean culture plot contains less moisture than any other plots. This is due, largely, to the inability of the barren plot to hold the rains and probably, to some extent, to lower moisture content

in the plot, due to evaporation before the rains fell. But since the surface foot shows a much lower per cent. than the second foot, it would indicate that the loss has been due, principally, to the former cause. In all other plots the excess of moisture is in the surface foot, showing covered plots to have retained the water by conducting it into the soil. If the rains are light and not of sufficient quality to collect on the surface, the barren plot will differ but little from covered plots in the amount of water which it retains. This was clearly shown in samples taken October 12th, of the preceding year (See Tables I and V).

September 19th to October 9th, when the next determinations were made, was a period in which no rain fell with the exception of October 1st and 2nd. The weather was warm for this season as Table VIII will show. Growth still continued and no frosts had occurred up to this time. Plots 5, 6 and 7 contain a much higher per cent. than other plots. Transpiration from growing plots has removed more moisture than has escaped by evaporation from the clean culture plot. The growth of the oats was checked by an attack of rust, and this crop is conserving moisture by acting as a mulch, while little moisture is being lost by transpiration. The corn which grew rapidly, reaching a height of five feet, was blown down by a heavy wind, October 1st. This practically stopped growth, and the crop provided a very heavy and effective cover, which is evident in the moisture figures for this date and also for succeeding determinations. The field peas were again killed by green aphis, late in September. Not enough was left for a very efficient cover, and the plot does not correspond to plot 5 at this date. The remaining plots 1, 3, 4, 8 and 9 which are growing, show but little variation in moisture content. Vetch is highest with 11.88 per cent.

From October 9-30th, was a period of light rains, (See Table VI) aggregating a little over two inches, consequently the plots all show increased amounts of moisture. The least increase has been in plots 5 and 2 respectively, and the deficiency in moisture has been in the second foot in each plot. This would seem to indicate that water was not conducted into the soil as thoroughly as in covered plots, where their deeply penetrating

roots, have aided percolation. The first foot in each case ranks as high in moisture as most covered plots. Evaporation was very slight on account of the frequency of the rains, and the prevailing cloudy weather. Of the covered plots, 3 and 4 show greatly increased gains over other plots. Of the remaining ones, there are no marked differences. Rape had at this time, practically ceased growing. On the 23rd of October, the first killing frost occurred. This was much later than in the preceding year, and the effects produced, at that time, are not noticeable in the samples taken October 30th, as only seven days had elapsed since the frost, and growth, at the time of injury, was not vigorous enough to show any great differences in so short a period.

From October 30th to November 15th, there were 1.30 inches of precipitation. All plots show an increase of moisture with the exception of the vetch plot.

Those plots highest in moisture content, are, 4, 7 and 9, showing the mulching value of rape, corn and buckwheat. Plot 6 is higher than the remaining plots, but the growth was not heavy enough to be of great advantage as a mulch. The vetch and rye plots are lower than plots above mentioned, and the plants were probably still taking up moisture to a small extent. Plots 1, 2 and 5 are lower than all other plots, the loss being due entirely to evaporation, as the moisture content of the surface foot, is much lower than in other plots. Soy beans, after the loss of their leaves, offer very little shade to the ground with their straight stems, and evaporation is not checked to any extent.

The next determinations were made November 25th. During the intervening days, there was little rain, the total being .31 of an inch. There is a great decrease in moisture in all the plots. With the exception of Plot 3, they occupy nearly the same position as in the preceding samples. Vetch has increased in moisture with reference to other crops and is next to the highest plot. As soon as growth stops with vetch, or is checked in any way, its wonderful mulching qualities at once become apparent. Rape has proven very satisfactory for the second season as a conserver of moisture. The corn and buckwheat plots also rank with vetch and rape in moisture content. The light rains of the

16th and 24th, have tended to increase evaporation by starting capillarity and the loss is very apparent in Plots 2 and 5, which are uncovered. In comparison with other plots, the loss has occurred in both the 1st and 2nd foot of soil. The soy beans and rye plots rank below covered plots, and the increased loss is due to the inefficient covering which these crops make. The amounts of moisture which the plots contain, are remarkably low for this period of the year, averaging less than any other time of sampling since August 26th.

The decrease probably began after the rains of August 5, 6 and 7, and continued, with but little check, until the samples were taken, on the 25th of November. On November 29th and 30th, .02 of an inch of rain fell, and from this date until the next determinations were made, (December 11th) the ground was frozen to a depth of several inches in some plots. In the vetch and corn plots, it was only in the least protected places, that any frozen ground could be found. From Table II it would appear that more moisture had escaped from these plots than from those in which the ground was frozen to a depth of several inches. The surface foot of the vetch and corn plots is lower, in moisture content, than other plots. There are great variations in the percentage of moisture in the second foot, and this was true for the preceding year, in samples taken when the ground was frozen.

On January 12th, the samples were taken, while the ground was covered with six inches of snow and frozen to a slight depth. The object was to find the moisture content of the plots at this period, and again after the snow had disappeared, to ascertain if there were differences in the amounts of moisture which the crops might receive from the melting of the snow. On January 13th, 14th, and 15th, light rains fell, and the snow melted rapidly. Before January 20th, it had all disappeared and samples were taken on that date. The results show that the majority of plots contain practically the same amounts that they did January 12th. Vetch is an exception to the other plots, and has increased in moisture over 2 per cent. This is probably due to the fact that it was not frozen to any extent and the water easily found its

way into the soil. In other plots, the frozen surface did not admit the water so freely, and they show but slight increases in moisture, while in plots 2, 6 and 9, there are small losses.

The next determinations were made January 29th. The unusually warm days, during the latter part of the month, lowered considerably the content of soil moisture. The amounts in the different plots do not vary to any great extent, except in the vetch plot, which still shows a higher per cent. than other plots. However, the water content of this plot was much higher on the 20th, and for the short period intervening, it has decreased to a greater extent than other plots.

On February the 12th, the samples were taken while the plots were frozen to a depth varing from 4 to 12 inches. The results show large differences in moisture, and there is a slight relation between plots frozen to similar depths. Those frozen deepest, have a higher percentage of moisture in the first foot than less deeply frozen plots, while the latter have a higher per cent. of moisture in the second foot. The total amount, however, for each plot does not vary to any large extent.

Samples of March 23rd were taken after the snows of the 11th to the 15th had disappeared, and after the heavy rain of March 19th. As a result there was a large amount of moisture present. The clean culture plot has retained much less of the water from the rain than any other plot. Plot 2 shows a much higher per cent. than it usually does under similar conditions. This is due to the fact that the vetch from the adjoining plot has spread over a large part of this plot, and it is now pretty thoroughly covered with vetch. For this reason this plot has been able to retain, approximately, as much moisture as other covered plots.

Plot 1, containing the soy beans, and which, with the exception of Plot 5, is the least covered, contained but 21.21 per cent. of moisture, or 58 per cent. more than the clean culture plot.

The rye and vetch, on account of the lateness of the season, did not make much growth until the second week in April. The moisture determinations made April 28th, were taken in order to show the effect of the growth of these crops in taking moisture

from the soil at this time. The differences are not large, due to the rains of the 25th and 26th, but there is a smaller per cent. of moisture in these growing plots, than is found in any other plot, with the exception of Plot 1, where evaporation seems to have been very heavy.

The clean culture plot, however, has not lost as much moisture as those plots on which crops are growing. Plot 2, on account of the vetch which has covered the plot, ranks low in moisture content. Plot 7 is highest with 24.60 per cent. The thick covering of corn has retained more moisture for this plot than has any other crop.

On May 15th, the last samples of the experiment were taken. This is much later than crops should be allowed to cover the ground, especially growing ones.

Plots 3 and 8 contain less moisture than any other plots, which shows the danger of late growth, as they rob the trees at a time when they need all the moisture available. Plot 2, with its partial covering of vetch, has lost more moisture than other plots, with the exception of Plots 5 and 1, where evaporation has been rapid on account of a lack of covering.

Buckwheat is comparatively low also, but the corn plot is very much higher than all other plots in moisture content.

The yearly average for each of the plots, show that the corn plot has contained the largest amount of water for the year, and that the clean culture plot has held the least. Next to this, is the soy bean plot, where the cover was less thorough than in any other covered plot. Plot 2, which was uncovered for the greater part of the season, is also low in moisture. Vetch and rye, which have stood high during the greater part of the year, owe their low percentage to the transpiration which took place while they were growing rapidly towards the end of the season, otherwise they would rank as high as any other plot.

TABLE V.

SHOWING MOISTURE PERCENTAGE FOR SECOND YEAR, AND AREA OF 1ST AND 2D FOOT.

Date.	Plots.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
July 9 —									
1st ft.	10.11	9.45	8.01	7.98	7.51	8.42	8.27	9.06	8.09
2nd ft.	7.21	9.56	9.54	9.00	9.28	10.00	9.33	9.46	10.61
Average	8.66	9.50	8.77	8.99	8.39	9.21	8.80	9.26	9.35
August 26 —									
1st ft.	9.28	9.55	11.07	8.97	8.84	9.79	9.21	10.71	9.14
2nd ft.	8.95	10.54	11.84	9.57	8.71	9.69	9.79	10.80	10.52
Average	9.11	10.04	11.45	9.27	8.77	9.74	9.50	10.75	9.83
September 19 —									
1st ft.	21.38	23.20	23.57	24.88	18.10	23.86	24.35	24.40	22.59
2nd ft.	20.64	20.09	21.66	17.27	22.93	23.39	23.28	20.26	19.35
Average	21.01	21.64	22.61	21.07	20.54	23.62	23.81	22.33	20.97
October 9 —									
1st ft.	12.54	11.00	11.89	11.59	11.57	11.90	12.57	11.80	11.14
2nd ft.	10.27	10.67	11.87	10.54	14.33	13.20	13.29	11.56	11.97
Average	11.40	10.85	11.88	11.06	12.95	12.55	12.93	11.68	11.55
October 30 —									
1st ft.	22.72	23.30	25.27	24.52	25.00	23.61	25.78	24.28	24.03
2nd ft.	21.92	18.87	24.80	21.63	18.68	23.31	20.83	22.36	20.96
Average	22.32	21.08	25.03	23.07	21.84	23.46	23.30	23.32	22.49
November 15 —									
1st ft.	23.61	23.39	25.00	27.17	23.58	25.47	26.10	24.56	25.55
2nd ft.	22.25	24.72	23.47	24.56	22.93	23.30	25.31	23.75	26.05
Average	22.93	24.05	24.23	25.86	23.25	24.38	25.70	24.15	25.80

TABLE V — Concluded.

SHOWING MOISTURE PERCENTAGE FOR SECOND YEAR, AND AREA OF 1ST AND 2D FOOT — Concluded.

Date.	Plots.								
	1.	2.	3.	4.	5.	6.	7.	8.	9.
November 25 —									
1st ft.	10.89	11.51	12.12	12.70	10.65	12.77	10.78	9.33	12.06
2nd ft.	10.75	8.79	12.03	11.02	9.66	9.15	12.02	11.33	12.77
Average	10.82	10.15	12.07	11.86	10.15	10.96	11.40	10.33	12.41
December 11 —									
1st ft.	26.02	26.35	24.80	28.65	25.18	26.58	22.88	25.97	25.59
2nd ft.	21.77	23.31	23.33	22.22	23.99	25.92	21.85	22.98	25.00
Average	23.89	24.83	24.06	25.43	24.08	26.25	22.86	24.47	25.29
January 12 —									
1st ft.	25.24	25.87	24.77	24.69	23.52	26.31	27.83	23.66	27.35
2nd ft.	22.33	24.04	26.26	24.53	25.00	25.97	23.12	23.33	23.83
Average	23.28	24.95	25.51	24.61	24.26	26.14	25.47	23.49	25.59
January 20 —									
1st ft.	24.24	24.19	25.58	26.26	24.46	25.78	25.15	25.00	24.58
2nd ft.	22.77	22.90	29.68	23.17	24.66	24.81	26.34	23.09	23.90
Average	23.50	23.54	27.63	24.71	24.56	25.29	25.70	24.04	25.24
January 29 —									
1st ft.	24.43	22.84	24.69	24.02	22.47	20.37	24.42	22.56	22.45
2nd ft.	23.00	22.07	24.00	22.15	22.87	23.83	21.02	21.93	25.40
Average	23.71	22.45	24.34	23.08	22.67	22.10	22.72	22.24	23.92
February 12 —									
1st ft.	36.42	35.51	28.19	34.25	29.68	27.71	26.81	26.22	28.82
2nd ft.	20.70	18.42	24.10	25.00	22.22	22.66	25.64	22.85	24.22
Average	28.56	26.46	26.14	29.62	25.95	25.18	26.22	24.53	26.52

4 *March 23* —									
1st ft.	26.26	31.75	38.78	25.09	26.61	30.16	29.61	36.50	37.56
2nd ft.	19.36	22.43	23.07	29.41	14.85	20.12	22.05	20.35	26.56
Average	21.31	27.09	30.92	27.25	20.73	25.14	25.83	28.42	32.06
April 28 —									
1st ft.	20.59	18.03	20.12	19.07	17.44	23.31	23.56	22.19	18.31
2nd ft.	19.57	18.78	21.41	25.63	27.11	21.38	25.64	21.73	26.56
Average	20.08	18.40	20.76	22.35	22.27	22.34	24.60	21.96	22.43
May 15 —									
1st ft.	20.50	16.29	15.44	17.24	17.19	....	22.97	13.90	17.42
2nd ft.	17.09	21.55	13.57	25.90	20.00	....	23.20	22.22	21.36
Average	18.79	18.92	14.50	21.57	18.54	....	23.08	18.06	19.39

TABLE VI.

DAILY PRECIPITATION FOR 2D YEAR.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	.45			1.50							.01
2	.47		.74	1.05							.58
3	.40						.99		.95		
4	.03							.02	.01		
5	.54	.55			.70			.24		.24	
6	.11	.63			.02						
7					.12		.16		.03		
8	.96						.33				.29
9										.27	
10			1.05								
11	.43	1.81	.08	.32					.70		
12	.13								.30		
13		.74					.01		.31		
14		.60					.04	.11	.25	.48	
15		.02		.06			.32			.02	
16			1.64	.16	.12	.07				.0	
17			.07								
18			.42	.09				.07			
19	.10	.55	.26	.51					1.19		
20						.08					
21						.71		.36			
22							.13				
23	.09					.23	.01				
24		.28		.20	.19				.12		
25		.04		.30		.02		.23		.19	
26									.08	.06	

27										.52		
28						.34	.08					
29		.06				.28	.02			.24	.28	
30								.04		.51		
31					.46		.05			.25		

TABLE VII.

SHOWING TEMPERATURE OF PLOTS FOR 2D YEAR, AND MEAN DAILY TEMPERATURE OF AIR.

Date.	Plots.									
	1.	2.	3.	4.	5.	6.	7.	8.	9.	Mean D. Temp.
July 19	76.0	76.0	75.5	75.5	76.0	76.0	76.0	76.0	76.0	82.00
July 28	74.5	74.0	74.0	74.0	74.5	74.0	74.5	74.5	74.5	76.66
August 18	69.5	69.5	69.5	69.0	69.0	70.0	70.0	70.0	70.0	72.33
August 26	68.0	70.0	69.0	68.0	70.0	69.0	68.0	68.0	68.5	69.00
August 30	69.0	69.5	70.0	69.0	70.5	69.5	69.0	70.0	69.5	77.33
September 12	61.0	62.5	61.5	61.0	64.0	62.0	61.0	62.0	62.0	68.33
September 16	62.5	64.0	63.0	62.5	64.0	63.0	62.5	63.0	63.0	72.66
September 30	62.0	64.0	62.5	62.5	64.0	63.0	62.5	63.0	62.5	69.33
October 16	54.5	57.0	54.0	54.5	57.0	56.0	56.0	56.0	56.5	49.66
October 27	50.5	50.0	50.0	50.5	50.0	51.0	50.5	51.0	50.0	42.66
November 1	47.5	47.0	48.0	48.0	47.0	47.5	47.5	48.0	47.0	46.00
November 7	46.0	45.5	46.5	46.0	45.5	46.0	46.5	46.5	46.0	43.33
November 18	46.0	45.0	46.5	46.0	44.5	46.0	47.0	45.5	46.0	44.00
November 27	41.0	41.0	38.5	39.0	41.0	39.5	38.5	40.0	40.0	35.66
December 12	35.0	34.5	36.0	35.5	34.5	35.0	35.5	35.0	34.5	28.33
December 13	34.5	35.0	34.0	34.5	35.5	34.5	34.0	34.5	35.0	29.33
December 23	34.0	34.5	35.5	34.0	35.5	34.0	34.0	34.0	34.5	29.33

January 11	34.0	34.0	34.5	34.5	34.0	34.0	34.0	34.0	34.0	28.00
January 22	33.0	33.0	35.0	33.5	33.0	33.5	34.5	34.0	34.0	32.00
January 26		37.5	40.0	38.0	37.0	38.5	39.0	38.5	38.5	33.33
January 29		36.0	39.5	36.0	35.0	36.5	37.5	36.0	36.0	36.66

TABLE VIII.

MEAN DAILY TEMPERATURE FOR 2D YEAR.

Date.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
1	76.00	70.33	71.33	65.66	46.00	29.33	29.33	27.33	37.00	37.66	64.00
2	74.66	69.33	70.33	60.66	35.00	38.00	34.66	10.00	51.66	45.33	70.00
3	79.00	71.33	66.66	58.33	46.66	22.66	46.66	22.00	47.66	48.66	56.33
4	77.66	75.00	64.50	61.33	42.33	20.66	33.66	34.00	30.00	59.33	68.66
5	76.66	73.66	61.33	65.00	44.33	27.66	32.66	10.66	30.00	46.66	58.00
6	75.33	77.33	64.33	56.00	44.00	31.66	29.66	5.00	33.00	42.33	54.33
7	74.00	75.33	65.66	58.66	43.33	38.66	33.00	4.33	35.00	52.33	45.00
8	73.00	75.33	68.33	61.33	35.66	33.00	20.00	11.00	41.00	59.00	46.66
9	74.00	79.00	67.33	60.66	46.00	38.00	13.00	18.66	38.66	57.33	42.00
10	80.00	77.66	66.33	64.00	34.00	30.00	24.33	13.33	42.66	49.00	48.66
11	77.33	77.00	66.00	46.66	31.66	46.00	28.00	20.66	32.33	50.00	58.33
12	75.33	78.66	68.33	41.33	47.33	38.33	30.33	37.66	21.66	54.33	72.00
13	76.66	73.66	63.33	56.66	43.66	29.66	32.66	40.33	25.66	70.00	70.33
14	78.66	74.66	60.00	61.33	28.66	30.00	38.33	22.66	27.66	58.66	73.33
15	80.00	71.33	66.66	60.66	39.66	32.33	47.33	11.00	25.00	44.33	76.33
16	78.66	67.00	72.66	49.66	40.00	33.00	31.66	20.66	22.66	43.66	.....
17	83.66	70.66	72.66	60.33	45.33	34.33	33.00	28.66	17.66	51.00	.....
18	82.00	72.33	73.66	65.00	44.00	36.00	37.66	33.66	20.33	59.33	.....
19	82.00	72.00	75.66	64.00	40.00	38.00	34.33	38.00	37.66	64.33	.....
20	78.66	72.00	63.33	44.00	45.66	40.66	62.00	50.33	22.66	62.33	.....
21	71.66	72.00	64.66	38.66	32.33	44.00	65.66	44.66	33.00	60.66	.....
22	73.33	77.33	69.33	44.00	36.66	41.00	62.00	39.66	17.66	48.00	.....
23	69.66	79.33	63.33	47.66	45.00	29.33	30.00	51.33	19.00	42.00	.....
24	68.66	74.66	68.00	49.66	51.66	24.00	33.33	58.66	24.00	51.00	.....
25	68.66	70.33	59.33	41.66	41.33	28.33	32.66	39.00	34.33	65.00	.....
26	69.33	69.00	35.33	46.33	43.33	37.00	33.33	31.66	48.33	65.66	.....

27	73.66	69.66	63.66	49.66	35.66	40.66	35.00	21.33	42.66	64.33	....
28	76.66	67.33	69.00	41.00	57.33	39.66	32.33	21.66	38.33	66.00	....
29	76.33	77.66	67.66	40.00	40.33	46.00	36.66	....	38.33	70.33	....
30	71.33	77.33	69.33	42.66	24.00	33.66	43.00	....	45.00	62.66	....
31	75.66	75.00	....	41.33	....	33.33	30.33	....	33.33	....	....

OBSERVATIONS ON TEMPERATURE.

First Year.

The temperature tables show the temperature reading for each plot. The average daily temperature, date and weather conditions, were always noted as well as the time of taking readings, as these conditions have an important bearing on the relation of the temperature of the different plots.

Owing to a delay in securing the temperature coils, the first readings were not made until October 8th. At this time all crops had made their growth.

At no reading were the differences in temperature very great at this season. On cloudy days, almost invariably, the least protected plots show a lower temperature than others, while on fair days, the reverse is true. Showing in the former case that the covers act as a blanket in retaining the heat, while it escapes more readily from uncovered or partially covered plots.

Likewise, when the weather is clear, the barren plot warms up more readily than a covered plot, and the temperature of these vary with the effectiveness of the cover. Thus for October 8th readings, taken at eleven o'clock, with a clear sky, show Plots 5 and 2 to be .5 of a degree warmer than other plots, while with vetch, which covers the ground most effectively, there is a difference from these barren plots of 2 degrees.

The temperature for the other plots show, very accurately, the degree with which they cover the ground.

October 10th. The weather had turned much warmer, the mean for this day being 71.66°. The morning was cloudy after a rain which fell in the night, but when the readings were made at noon, it was clear. As a result, there are no marked differences between unlike plots. The highest reading is for the rye plot, 61.5°, while the lowest is for the rape and corn.

On October 29th, which was cloudy, the uncovered Plots 2 and 5 show the lowest temperatures, followed by 1 and 9. In the vetch and oats plots, the readings are one degree higher, while in remaining plots, the difference is .5 of one degree.

Vetch and oats cover the ground more thoroughly than other plots, while cow peas and buckwheat have the least effective covering, excepting, of course, Plot 2, where the field peas were destroyed by aphids.

The readings for November 14th and 16th, while from 3.5 to 4.5 lower, show the same relative difference as the readings of October 29th. The readings were all taken at similar hours and under similar weather conditions. The more exposed plots have much lower temperature, while the covered ones are much warmer. (See Table VII.)

On December 5th, the daily average temperature was 29.33, which is below freezing. The day was cloudy, and while the unprotected Plots 2 and 5 are lower than other plots, the difference is very slight, and the light crust of frozen ground has doubtless prevented, to a small extent, the loss of heat from the soil.

On December 10th, snow fell to a depth of six inches, this remained on the ground until about the 24th of December, then melting gradually. After this date there was still three inches of snow on Plot 6, and a small trace on Plot 9. The upright condition of the oats had retained more snow than other plots, as there was a strong wind when the snow fell, and the upright growth of the oats prevented the snow from blowing off.

Freezing weather followed the disappearance of the snow, (See Table VIII) and the snow remained on Plot 6 for one month. The temperature readings from the 24th of December until the 23rd of January. show the influence of a cover of snow on the temperature of the ground beneath. While the difference is not large, it is persistent in the readings, following the disappearance of the snow from the other plots. By referring to Table III, December 28th, it will be seen that the temperature for the oats plot is 42 degrees. This is one degree warmer than the plots on either side, three degrees warmer than the lowest plot, and .5 degrees warmer than the next highest plot. For the succeeding readings, until January 16th, this higher temperature for the oats plot is maintained. The readings were made at different hours during the day, and in all cases there is a slightly higher temperature for Plot 6. It will be noticed, from the tables,

that this plot usually shows a high temperature, but during the time that it was covered with snow, the difference is so marked, that it seems safe to conclude that the increase in temperature was due to this snow cover. The vetch plot shows a relatively higher temperature than other plots for this period, and while it is one of the first plots from which snow disappears, the vetch forms such a thick covering and mats so closely, that it protects the ground very thoroughly from temperature changes, and maintains a very high degree of warmth in comparison with other plots.

By January 23rd, the snow had entirely disappeared from Plot 6, and the plots were under uniform conditions. The average daily temperature was 22.66°.

Plots 1, 2 and 5 which are unprotected, show a temperature at the freezing point. All other plots are from one to one and five tenths degrees higher. This reading indicates, very clearly, the effectiveness of the different covers. Vetch, oats and corn are highest, and a glance at photographs of these plots, will show why this is true. Rye and buckwheat are a trifle lower, but slightly warmer than the unprotected plots. The temperatures occur in nearly the same relation in the readings for February 1st. Three inches of snow fell at this time, but it had no noticeable effect on the temperature of the plots as the ground was frozen to quite a depth at this time. The coldest weather of the season occurred during the first half of February, the lowest daily average being 2.66 degrees on February 15th. (See Table IV).

Observations on depth of freezing, made at this time, show all plots, but 2, 3 and 8, to be frozen to a depth of ten inches, or more. The readings of February 6th, show the temperature of all plots to be below freezing. Vetch is highest with a temperature of 31.5°.

The readings for February 14th are practically the same. Plot 5 has dropped to 29.5°. Chart IX shows that this plot was frozen to a depth of 16 inches. This would extend nearly to the bottom of the temperature coil. Plot 4 is frozen to a depth of 18 inches, and the temperature is 30°.

The weather began to moderate about the 17th of February,

but the ground remained frozen for some time, and none of the plots show a temperature above freezing until March 16th. On February 24th, Plot 6 has a temperature of 32° while Plot 3 is 31.5°. It would seem that the latter plot, which was frozen to a depth of only 6 inches, would warm up more rapidly than other plots, but it is this feature of the vetch which makes it valuable as a cover. Its close covering prevents rapid thawing, and a glance at the readings from February 1st to March 16th, will show what a comparatively even temperature it has maintained.

On March 16th, all plots have a temperature of 32 or above, except Plot 5. There is a marked increase in the average daily temperature at this time, and the frost all left the ground. The readings for March 24th and 27th and April 4th, taken at 11 a. m., show the different effects of fair and cloudy days on the plots. March 24th was cloudy during the entire forenoon.

The readings show Plots 1, 2 and 5 to be colder than other, or more effectively covered plots. On the next date of observation, when the sun had been shining brightly all morning, these uncovered plots show a higher temperature, in most cases, than the covered plots. Plot 3 is lower than all other plots, due to the thorough covering of the vetch, which does not allow the sun's rays to penetrate readily.

The same conditions hold for the observations of April 4th. Plot 3 is lowest in temperature, while the uncovered plots are highest in most cases. These results indicate, very clearly, the value of cover crops in protecting tender rootlets from sudden changes caused by the many metereological conditions to which they are subjected. While these changes are not especially harmful at this season of the year, the tree is given more favorable conditions for growth.

On April 6th, some of the plots were slightly frozen, where not protected. The temperatures of these plots, 1, 2 and 5, are lower than other plots, which is a result of the freeze. No frozen ground was found under well covered plots.

April 13th, observations made at 10 a. m. The day was fair, and the usual results were obtained, under like conditions. The more exposed plots are nearly all warmer by two degrees.

while Plots 3, 6 and 8 are lowest in temperature. The rye was growing rapidly at this time, and had shaded the ground to such an extent that it is easily noticeable in the temperature readings. Vetch is also growing, and the matted covering is even more effective than heretofore.

On April 21st, the readings were made at 8 a. m. Under these conditions the more protected plots are found to be the warmest. Their coverings have prevented the escape of heat from the soil to a greater extent than plots which are barren or have but a slight covering. On April 22nd and 25th, the readings were taken at noon, on clear days. As usual, the table shows the highest temperatures on plots most exposed to the sun's rays. Plot 8, at every observation, now coincides with well covered plots. On May 13th, the last reading of the season was made, just before the crops were plowed under. The day was clear and the time was 3:30 p. m. Plots 3, 4 and 8 have a temperature of 47.5° while Plots 1, 2 and 9 have a temperature of 30°. The remaining plots have temperatures between these two.

OBSERVATION ON TEMPERATURE.

Second Year.

The temperature observations of the second year coincide with the general results of the first season, that is, like conditions have produced like results. The same crops, however, have not, in every case, produced the same results as in the preceding season. These differences are due to the effect of a longer growing season on the crops, and also to different conditions which prevail during this season. The first readings were made on July 19th, before any crops had started to grow. The results are those that would naturally be expected. Table VII shows that the greatest difference in temperature has been but .5 of one degree. The prevailing temperature being 76°.

Practically the same results are true for the next two readings. While the crops had all sprouted at this time, the growth had not been sufficient to effect the temperature. On August

26th, the first appreciable differences are noted. Plots 2 and 5 have the high temperature of 70°. The field peas of Plot 2 were killed by the green aphis, as in the preceding year, before much growth had been made. This left the plot almost barren, and consequently it coincides with Plot 5. The vetch plot has a temperature of 69°, which, with the oats plot, is next highest in temperature. These crops had made but little growth at this time, in fact oats did not grow very vigorously at any time. The many rains of August were very favorable to the development of rust which attacked the crop and very materially effected its growth. Other crops made a rapid growth, favored by the plentiful rains. The observations for this date were made at 3 p. m., on a clear day, and the highest temperature are found on the more exposed plots. On August 30th, the readings were taken at 2 p. m. The day was fair, and the results are similar to the preceding.

September 12th, 4:30 p. m. Fair. The growth of the vetch was now noticeable on the temperature, and Plot 3 is cooler in comparison with other plots, than it has been in preceding readings. Plots 2 and 5 are warmer than any others. The same results are found for September 16th and 30th, under similar conditions. For October 16th, the temperatures for Plots 2 and 5 are very much higher than other plots. Observations were made at the warmest period of the day. The next four readings were made at 8:30 a. m., on October 27th, November 1st 7th and 18th. The variations are not very marked, but Plots 2 and 5 are, in each case, from .5 to 1.5° cooler. On November 27th, readings taken at 1 p. m. Fair. show these plots higher than other plots. And again on December 12th, 9 a. m., they are lowest in temperature. The next day at 2 p. m., the reverse is true. These readings show the fluctuations in temperature which uncovered plots undergo. They cool to a lower temperature during the night, than covered plots, and when exposed to the heat of the day, they are, in every case, heated to a higher temperature.

During the first week of January, there was a snow fall of 6 inches. The observations made January 11th, show the even

temperature of all the plots under a covering of snow. These figures also show the warmth maintained by the snow. A glance at Table VIII will show the daily temperature for this period.

On January 22nd, after the snow had all disappeared, there are marked variations under the different crops. The vetch plot is two degrees warmer than barren plots, and warmer than all others. Readings were made at 9 a. m., weather fair. The last two readings for January were taken at 11 a. m. The days were cloudy and Plot 3 records the highest temperature in each reading. Plots 2 and 5 are lowest, having lost heat during the night and not regained it as the day was cloudy. (The coil in Plot 1 was destroyed and could not be replaced).

On February 7th, with 5 inches of snow on the ground, the temperatures are again nearly uniform, as was true for January 11th. February was a very cold month, and the ground was frozen to varying depths under the different plots. The time of taking the readings and the condition of the weather have little effect on he temperature of the plots for this month. They are controlled, largely, by the depth to which the plot has frozen.

By comparing the temperature readings of February 10th, with the depth of freezing from observations made in the same date, it will be seen that the temperature of the plots follow, very clearly, the depth to which they were frozen.

On February 20th, the temperatures were taken at 4 p. m. There was some frost in all the plots, except 3 and 7. It will be remembered that these plots were only frozen to a depth of four and five inches, respectively. The temperature of these plots is from two to four degrees warmer than other plots. On February 22nd, two days later, the results are very similar.

EFFECT OF COVER CROPS ON DEPTH OF FREEZING.

One of the most important advantages of a cover crop is the protection which it affords against deep freezing. In the observations made on the depth to which the ground was frozen in the several plots, large differences were found to exist, and the

measurements made, show the value one crop may possess over another in this respect. The differences between the crops are here more pronounced and persistent than in either the moisture determinations or temperature readings. The measurements were taken during the coldest periods of each season. In making the observations, the depth of the frozen ground was measured at two different places in each plot, and the average found. These are shown in Charts VIII and IX. It will be seen that for each measurement the crops bear a similar relation to each other in the depths to which they have frozen. There is a slight difference for the two seasons, due to the different growth made by the crops.

The first measurements were made December 13th, 1904. The greatest depths of freezing were found in the rape and clean culture plots, the depths being 8 and 7 inches respectively. Vetch had frozen to a depth of only 2.5 inches, white oats, corn and rye, show a depth of from 3 to 4 inches. Plot 2, which is almost barren, is frozen 6.5 inches, nearly as deeply as Plot 5. On February 12th, 1905, which was the coldest period of the winter, the ground was found to be frozen to depths varying from 6 to 18 inches. The rape plot contained a very small amount of moisture during the late fall and winter, and being so dry, the ground was frozen to a depth of 18 inches. Next to this is a depth of 16 inches in the clean culture plot. The smallest depth was 6 inches in the vetch plot. Other plots range from 10 to 14 inches, according to the effectiveness of the cover.

In the measurements made December 9th and January 27th, of the second season, it was only in the most exposed places of the vetch plot that any frozen ground existed. Where the crop covered the ground thoroughly, it was not frozen at all. The corn plot, likewise, showed very little frozen ground. The clean culture plot was frozen deepest, together with Plot 2, which was without a cover.

The measurements made on February 10th, were at the coldest period of the year. The greatest depth of freezing was 12 inches in Plot 5, and the least depth was 4 inches in the vetch plot. This shows the remarkable protection afforded by this crop.

For the ten days preceding the measurements, the daily temperature averaged 15 degrees, and yet the ground was only frozen 4 inches deep under this crop.

Corn has also protected the ground very thoroughly from deep freezing, giving an average depth of 5 inches. In comparing these measurements with those of February 12th, of the preceding year, a marked difference is noted in the depth of freezing. This is due, largely, to the large growth made by the crops during the second season, when they were sown earlier, and thus covering the ground more effectively. A difference is also noted in the rape plot, which compares very favorably with the other crops in the protection which it has afforded. The ground was not so dry under this crop as it was the preceding year, when it froze to a depth of 18 inches. This depth undoubtedly reaches a large majority of the more tender rootlets, and great injury is likely to be done. The measurements of February 10th, 1906, show, very clearly, the valuable effects of a cover in protecting the roots of trees against deep freezing and also the relative value of the several crops in this respect, as their relations are really the same in all measurements.

CONCLUSIONS.

The time at which a cover crop is sown, determines, quite largely, its effect on the moisture content and temperature of the soil, and its value as a cover. Different weather conditions affect some crops differently from others, and are influential in determining the value of the crop. This was clearly shown by the rape and oats for the two years; the former, for the second year, gave more valuable results than during the first. These results were due to the rains which came very opportunely and did not allow the rape to dry the ground so completely as during the first year, consequently it served as a better protector against deep freezing, and in maintaining a more even temperature.

In regard to oats, the many rains proved detrimental to the crop in aiding the development of rust. This did not produce the valuable effects for the second year that it did for the first.

With rye and vetch, the time of sowing is not of so great

importance, as they grow quite late, and usually make a sufficient cover. Soy beans, cow peas, and buckwheat, are rapid growers, usually coming in bloom in about one month after planting. No marked differences can be seen between these crops for the two seasons. On account of the attack of the green aphis, field peas, as a cover crop, was a failure. The destruction of the crop each year makes their use impracticable, especially where the aphis is abundant.

In regard to the quantity of organic matter that the crops produce, corn is of the greatest value. In each year it made an enormous growth, tasseling out, the second year, in about six weeks. No difficulty was experienced in plowing it under, as the stalks do not attain sufficient size and hardness to become troublesome in this respect. With rape the stems and leaves, although making a large growth, are so succulent that the quantity of material is quite small when time for plowing comes. The roots, however, are very large and penetrate the soil so deeply and thoroughly that the texture is greatly improved, and the soil is in fine tilth when plowed.

The supply of humus from these roots makes up largely for the small amount produced by the stems and leaves.

Oats, for the first year, produced a large amount of material and the soil was found to be in good tilth when the crop was plowed under. For the second year, the rust injured the crop to such an extent, that only a small quantity was left and its value as a supply of humus was of but little consequence.

Cow peas, soy beans, and buckwheat, loose their leaves soon after the first killing frost. These are blown away and the stems which are left, are of little value. Vetch and rye do not supply a large amount of organic material, but in this locality both live through the winter, and begin growth early in the spring. In this way, they are very valuable, both in taking up the soluble salts before the tree roots become active, and as a source of green manure.

These crops grow very rapidly and must be plowed under before an excess of moisture has been removed, or as soon as the ground can be plowed in the springtime.

The amounts of moisture which the different crops retain for a season, appear to be of little importance as they do not vary to any great extent. The most valuable cover crop, in regard to moisture, is the one which removes the largest amount of moisture for the soil while growing, thus hastening the maturity of the tree, and making sufficient growth to cover the ground thoroughly and retain as much moisture as possible for the remainder of the season. Then when plowed under, the greater the amount of humus, the greater will be the ability of the soil to still retain moisture in future seasons

In each year the clean culture plot shows a very low per cent. of moisture in comparison with other plots, while the other plots bear a similar relation to each other for the two years.

Corn was superior to all other crops in its effects on moisture. It grew rapidly, and removed large quantities of water from the soil. After growth was finished, it formed a very heavy covering, and but little moisture was lost by evaporation. Rape removes more moisture from the soil than other crops, while growing, but it is not as valuable as a cover. Vetch forms a better mulch, by far, than any other crop, but does not take moisture from the soil as rapidly, while growing, as some other crops. Cow peas, soy beans, and buckwheat, by their rapid growth, remove a large amount of moisture, but as a mulch, they are of little value. Oats, when growth is favorable, are valuable in both respects and in addition, retain snows better than other crops, and in this way adds moisture to the soil.

In regard to temperature, some crops maintain a more even temperature than others, and all covered plots are superior to the clean culture plot. Vetch appears to be more valuable than other crops, in protecting the soil from these sudden changes of temperature.

Corn, where growth is sufficient, is also very good. These two crops are likewise excellent protectors against deep freezing, especially vetch, which does not ordinarily allow freezing to a depth which would become dangerous to roots.

Careful observations were made on the time at which the buds began to open on the trees of the different plots. No dif-

ferences were noticed that could be attributed to the effect of the covers on soil temperature. The time of budding is undoubtedly due, largely, to the temperature of the surrounding air and not to the temperature of the soil to any extent.

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Insects Affecting the Poplar*.

ROBERT A. YOUNG.

The family Salicaceae, which is constituted by the genera of woody plants, Populus and Salix, seems to be peculiarly attractive to leaf-eating, boring and sucking insects. The insects feeding on the various species of poplar, were made a subject of some study, by the writer, during the latter part of 1905, and the first half of 1906. In the limited time which was available, it was, of course, impossible even to observe very many of the forms, and of those found, still fewer could be studied at all adequately.

The cottonwood twig borer, Oberea schaumii Leconte, was undoubtedly the insect most injurious to the Cottonwood and Carolina poplar, in Columbus, during 1905-6. The larvae are borers in the smaller branches of these trees. The white-marked tussock moth, Hemerocampa leucostigma Abb. & Sm. was found to occur quite commonly on the Carolina and Lombardy poplars, in Cleveland. The oyster-shell scale, Lepidosaphes ulmi Linn., was one of the most serious pests occuring on the poplar during the years mentioned, in the northern part of the state, particularly in and about Cleveland. The results of my investigations of these three insects will be given here, and a list of the species which I have observed or have found recorded elsewhere as feeding upon the poplars, will be appended.

The Cottonwood Twig Borer.

(*Oberea schaumii* Leconte.)

As has been stated, the larvae of these beetles work in the medium and small-sized branches of the Carolina poplar. In some trees it is almost impossible to find a branch two years or more old, that does not bear evidence of their work. The burrows or galleries are usually made near the pith, sometimes following

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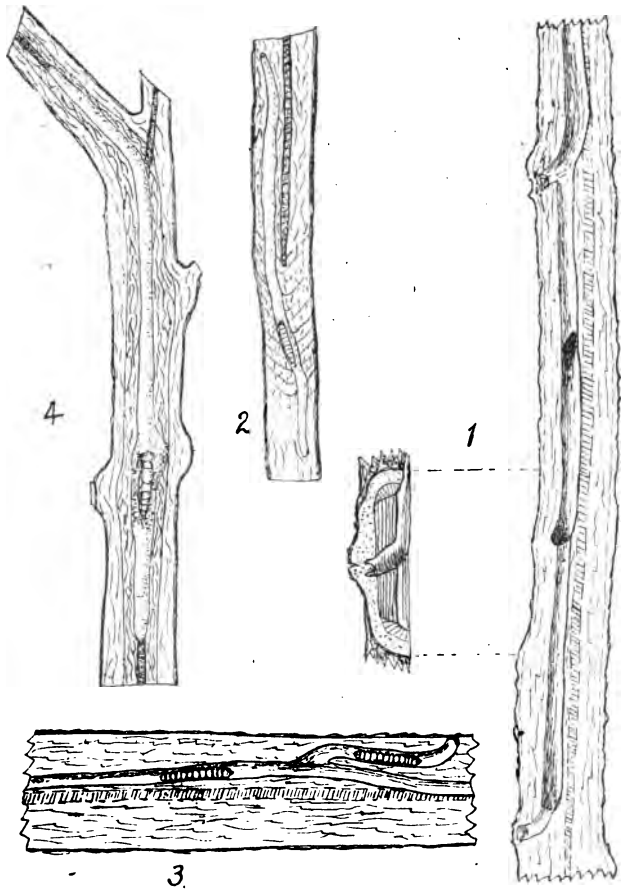
it directly for short distances. They do not, however, often pursue a straight course very far, but are usually more or less curved and winding (figs. 2-3). The length of a burrow made by a single larva is about four and one-half to five inches. The remains of an adult which has not emerged, are occasionally found in an isolated burrow, (fig. 4) so that the work of an individual borer can be determined quite accurately.



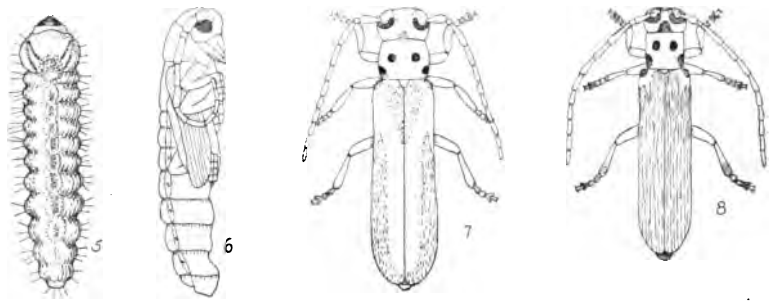
Work of the Cottonwood Twig Borer. 1, gallery, showing four exits; 2, a winding gallery; 3, branched gallery containing two full-grown larvae; 4, completed burrow, with adult borer that did not emerge.

In some older branches, it is almost impossible to find a burrow that does not connect with one or more others. In fig. 1 is shown a continuous gallery in which four exits appeared within a space of less than six inches; two or three galleries, more or less nearly parallel for short distances, are sometimes met with in branches four to six years old. In one case, in mid-winter, two full-grown larvae were found, not over an inch apart, in a branched gallery (fig. 3); the short spur from the main gallery here was excavated clear out to the bark.

The length of a full-grown larva varies between three-fifths and two-thirds of an inch, the females probably being the larger (fig. 5). There are no traces of feet. The body is yellowish white, and the head and dorsal part of the prothorax are light brown. On the posterior part of the latter, is a small area, dotted with a deeper shade of brown, and from this, two pairs of curved sutures proceed forward, diverging slightly. The mandibles are black. The entire body is sparsely covered with hairs, but these are scarcely visible without the aid of a lens. A spiracle appears on either side of each of the first eight abdominal segments (not seen in a dorsal view).

A pupa, taken May 8, is shown in Figure 6. The borer pupates naked. Pupae that were apparently in about the same stage of development, began changing to adults by the middle of May, and this continued for about a week with the specimens in breeding cages. The exits are round holes, slightly more than 3/32 inch in diameter. It may be stated here, that in nearly every instance the larvae and adults were headed towards the outer end of the branch. Eight adults emerged in captivity, and of these, seven were males. The adult female (fig. 7) is about five-eighths of an inch in length, and the male, (fig. 8) nine-sixteenths of an inch. The head and thorax of the adult are mainly brown. There are four shining black callosities on the thorax, the anterior pair being the most conspicuous. The black color of the posterior pair is continued in a dull shade, back to the elytra. On the posterior median portion of the head, is a somewhat triangular dull black patch. The outer anterior corners of the elytra are marked with a similar color. The scutellum is brown, and the

femora and the tibiae, except at the tips, are of the same color. The tarsi are black, five-jointed and clawed. The antennae are eleven-jointed and black; the second segment is very short. The base of the antenna is very pubescent; this condition extends across the front of the head. The eyes are black and each one extends part way around the outside of the corresponding antenna. The under part of the body is mainly black. In the male, the elytra are dull black, except a small tract on each anteriorly, which is brown; the tip of the abdomen, ventrally, is brown. In the female, the inner anterior part of the elytra are black, also the outer posterior, two thirds. Except for the outer anterior black corners, the remainder is brown. The two posterior segments of the abdomen are brown on the ventral surface.



Cottonwood Twig Borer. 5, fullgrown larva; 6, pupa; 7, adult female; 8, adult male.

As has been mentioned, this insect works largely in the branches of the Carolina poplar: in some trees one can hardly find a branch two years old or more, that does not bear evidence of its work; usually, however, the rapid-growing branches do not seem to be so much affected. Larvae of widely varying sizes were found in early spring, and also in late fall and winter. No pupae were found during the fall, winter nor very early spring, although full-grown larvae were numerous. From these facts it would seem that either the larva requires more than one year for growth, or that the adults issue throughout the summer. An attempt was made to determine this point by enclosing portions

of living branches, which appeared to be infested, with wire screen, to prevent further egg-deposition, and entrap any adults that might emerge. This was done early in May, 1905. Examination was made a few weeks later, again in September, and then again in the following June, but the results were negative, no beetles being caught. Another point was observed which may throw some light on this question; on May 17th, a branch which had been broken off by the wind, in the two-year growth, was found to contain an old gallery in the part broken, from which the adult had evidently escaped the preceding year, for the exit was over-grown by later wood. Thus the wood could have been only one year old when the borer emerged. It is not impossible, however, that the insect commenced work in the outer end of the wood that was still one year older.

No eggs of the beetle were obtained.

Deserted galleries are often inhabited by inquilines. Dipterous larvae were found in several instances, and an adult of a species of Crabronidae, of the Hymenoptera, was found in one burrow. The remains of flies were occasionally present, presumably carried in by Crabronids.

Most of the material with which I worked, was obtained from the branches of pruned trees, that were left lying in vacant lots, and from branches broken off by the wind, which are to be found after almost every storm in the spring. Where the larvae are full-grown, they readily transform to adults in such branches, and the importance of burning pruned branches is therefore evident.

The borer is preyed upon to some extent by Hymenopterous parasites. I found a number of pupae of one of these forms, which was determined by Dr. Ashmead, of the Bureau of Entomology, to be a member of the genus Pimpla of the Ichneumonidae. However, the number of these which I found was much smaller than the number of borers, so it would seem that at present the parasites are merely keeping a slight check on the borers.

THE WHITE-MARKED TUSSOCK MOTH.

(*Hemerocampa leucostigma* Abb. & Sm.)

Though the larvae do great injury to the foliage of trees in some parts of the country, I have not had opportunity to witness any very destructive work by this insect. In the winter of 1905-6, however, I found egg-masses and old cocoons quite abundant on Lombardy and Carolina poplars in Cleveland. One tree, about a foot in diameter, had attached to the bark, at a height of from seven to nine feet, twelve cocoons, many of which held egg-masses.

The female moth is wingless. The males are attracted as soon as she emerges, and after pairing, she commences egg-deposition on the cocoon, from which she has just come. When this is completed, she dies. The eggs are recorded to number between 100 and 500 in a mass. I found egg-deposition taking place the first week in August, in Cleveland. The species is normally single-brooded at Albany, N. Y., according to E. P. Felt, State Entomologist, but farther south it is two, and in Washington, D. C. even three-brooded.

This insect is reported as being commonly destructive to only a few trees, but has been recorded as feeding on a considerable number, as follows: linden, horse-chestnut, buckeye, maple, boxelder, honey-locust, apricot, garden plum, wild plum, garden cherry, choke-cherry, rose, pear, apple, quince, ash, black walnut, hickory, elm (several species), sycamore, butternut, oak, birch, alder, willow, poplar, spruce, fir, larch, and cypress.

The white-marked tussock moth is parasitized by a number of Hymenopterous insects, both in the larval and pupal stages. Early in July, I picked up a caterpillar with the idea of rearing an adult, but in a few days it died and shrivelled up. Shortly afterward, small, white, cottony cocoons were noticed in the box in which the caterpillar was kept. These cocoons and the larva were kept, with an egg-mass which had been collected, in a tight pasteboard box over winter. When examined late in the following spring, some black Braconids were found to have emerged, and also some yellow-and-black chalcids. The former, I believe

to have been the adults of the parasites of the larva, and were determined by Dr. Ashmead as Glyptapanteles sp. The chalcids, I believe, feed upon the eggs, for I found no young tussock-moth larvae, and yet the substance of the eggs was gone. This form was identified by Dr. Howard as Isodromus iceryae How(?).

Several cocoons of the moth, collected in the latter part of December, and kept wrapped in paper, in a living-room, during the remainder of the winter, were found to have contained several individuals of an ichneumonid. Male and female, of the parasite, were present. The male is about .35 inch (9 mm.) in length, and the female, .39 inch (10 mm.), exclusive of the ovipositor, which was extruded about .12 inch (3 mm.). The body of each is black, and the legs are brown, with the tibiae and tarsi black-and-white. Dr. Ashmead determined this form to be Pimpla pictipes Walsh. Dr. Howard has shown that there are at least twenty-one primary parasites of the tussock moth; but he also states that there are not less than fourteen hyper-parasites, which become so numerous at times as to almost exterminate the primary ones.

Birds constitute an important agency in keeping this insect in check. Mr. E. H. Forbush, Ornithologist of Massachusetts, has named nine native birds that are known to feed upon these hairy caterpillars. He also lists 38 other birds that eat other hairy caterpillars and thinks probably all of them will feed upon this one.

Probably the most practical methods of dealing with this pest, directly, are to apply oil of creosote to the egg-masses, which are white and quite conspicuous, or to gather and destroy them. If the latter is done in fall or winter, care should be taken not to collect cocoons without eggs, for this does no good and will destroy many beneficial insects.

THE OYSTER-SHELL SCALE.

(*Lepidosaphes ulmi* Linn.)

This scale-insect, in the past, has been rather commonly known as Mytilaspis pomorum Bouché, and it has also, at various

FIG. 9. Twigs of the Carolina Poplar incrusted with the Oyster-shell Scale.

times, borne many other names. A list of these synonyms is given in bulletin No. 88, of the Hatch Exper. Station of the Mass. Agr. College.

This insect occurs on many fruit and shade trees, almost all over Ohio, and in many other parts of the country. In Cleveland, where it was observed and where I collected material, the Carolina and Lombardy poplars frequently have their branches almost literally covered by the scales (fig. 9). Living twigs, gathered in December, had scales clear to their tips.

The scales are shaped somewhat like oyster-shells, which gives the insect its common name. The length of the scale of a mature insect, is usually about one-tenth of an inch (2 1/2-3 mm.). The scales are frequently curved, and the relative length and width is variable. They are formed, by concentric rings, from the small end toward the large. The adult insects perish in the late fall or early winter, and so the species survives the winter in the egg stage. The eggs average .0126 x .0063 inch (.32 x .16 mm.) in size and are white, semi-transparent and often more or less irregular in form. The number of eggs varies from about thirty to at least as high as ninety under one scale. The eggs hatch in spring, and the young insects scatter out over the twigs in great numbers. Infested twigs, kept in a warm room, became covered with the minute larvae as early as the middle of March.

Late in the winter while examining eggs from material which had been kept in the house since the first of January, I found small Hymenopterous larvae under some of the scales. Usually the larvae occurred singly, though occasionally two were found under one scale. Empty egg-shells as well as perfect eggs of the scale-insect, were always present, and from this it was evident that these larvae were parasites. There was some variation in the size and color of the larvae; the smaller ones measured about .03 x .015 inch (.8 x .4 mm.). The color was always some shade of yellow, sometimes slightly greenish.

Early in March I began finding pupae of the parasites, some yellow, and some black as they became almost mature, and a month later the adults began to appear. The first of these were

dark steel-blue in color, had 11-jointed antennae, and a spine on the tibia of the middle leg; the eyes were hairy; some individuals had a length, exclusive of wings, of about .03 inch (.8 mm.) or less, and some about .047 inch (1.2 mm.). The latter had the same characters as the former, except that the genitalia were slightly extruded, and were probably the females of the same species. The form of the antennae showed that these parasites belonged to the Chalcididae. A specimen sent to Washington, was determined by Dr. Ashmead to be Adelencyrtus sp. nov. (fig. 10). In the middle of April, yellow Chalcids (fig. 11) began to emerge and continue till the latter part of May. In this form the antennae are 6-jointed, and the ocelli are of a reddish color; the tibia of the middle leg bears a spine as in the preceding species.

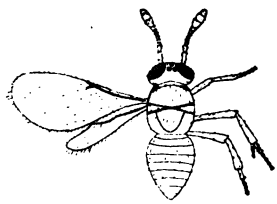


FIG. 10. Adelencyrtus sp. nov.

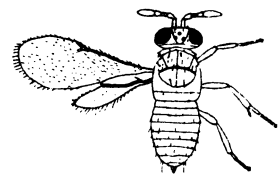


FIG. 11. Aphelinus diaspidis How.

This yellow form seemed to agree with the description of Aphelinus diaspidis How., and Dr. Howard later confirmed this.

On June first, two other chalcids appeared. The larger of these measures .05 inch (1.3 mm.) in length, exclusive of the wings, is a bright metallic green on the dorsal parts of head and thorax, the abdomen is blue, and the wings mottled with dusky patches. The antennae are 11-jointed, and there is a spine on each tibia. The eyes are not hairy. This was determined by Dr. Ashmead to be Habrolepis dalmanni. The other form was about .039 inch (1 mm.) in length and the head and thorax were greenish and black. The head is quite broad and the abdomen is short; the antennae of the male are 3-jointed and of the female, 5-jointed. There is a spine on each of the tibiae of the first and second pairs of legs. Dr. Ashmead determined this as Arrhenophagus coccois Auriv.

These last two forms are stated by Dr. Howard to be indigenous to the Chinese or Indian fauna and therefore of much interest as occurring in Ohio.

After practically all the parasites had emerged, leaving a small hole in the scale in each case, I made a count of the total number of scales on one of the twigs which I had, and of the number of these that contained holes, and found that 27% of the total number had been parasitized. As no parasites would develop under the male scales, the proportion of the scales containing eggs destroyed, would probably be much larger. Occasionally a scale was found containing two holes, so it is evident that two parasites may develop under one scale. Eggs that were apparently good, were found in a few instances, under scales where the parasite had pupated and it would, therefore, appear improbable that the oyster-shell scale should be exterminated by these egg-parasites.

In considering the time at which the chalcids appeared, it must be remembered that the material was kept in a warm room during a good part of the winter, so that the adults probably emerged several weeks earlier than they would under normal conditions.

Dr. Felt, of Albany, refers to six hymenopterous parasites on the eggs of the oyster-shell scale, all of which are different species from the four recorded here; he also states that coccinellid larvae and certain mites, prey upon the insect. The treatment advised, is some contact poison applied before the young have formed a thick scale, which, for the vicinity of Albany, is the early part of June.

LIST OF INSECTS KNOWN TO FEED ON THE POPLARS.

SUCKING INSECTS.

Hemiptera.

Family Aphididae.
- Aphis populifoliae Fitch
- Pemphigus popularius Fitch
  - populicaulis Fitch
  - populi-globuli Fitch
  - populi-venae Fitch
  - populi-transversus Riley
  - vagabundus Walsh
  - populiramulorum Riley
  - populimonilis Riley
  - pseudobyrsa Walsh
- Melanoxanthus salicis Linn.
- Callipterus (?) sp.
- Chaitophorus candicans Koch
  - populicola Thos.

Family Coccidae.
- Lepidosaphes ulmi Linn.
- Aspidiotus perniciosus Comst.
- Pulvinaria innumerabilis Rathv.
  - occidentalis Ckll.
- Chionaspis ortholobis Comst.
  - salicis Linn.
  - salicis-nigrae Walsh.

LEAF-EATING INSECTS.

*Lepidoptera.**

Family Papilionidae
- Papilio glaucus Linn.
  - glaucus turnus Linn.
  - thaos Linn.

Family Nymphalidae
- Euvanessa antiopa Linn.
- Basilarchia arthemis Drury.
  - archippus Cramer
- Eugonia j-album B. & L.

* The nomenclature here followed is that used in Dyar's List of No. Am. Lepidoptera.

Family Hesperiidae
Thanaos icelus Lintner
persius Scudd.
Family Sphingidae
Marumba modesta Harris.
modesta occidentalis Hy. Edw.
Smerinthus jamaicensis Drury.
Paonias excaecatus Sm. & Abb.
Family Saturniidae
Telea polyphemus Cramer
Samia cecropia Linn.
Antomeris io Fabr.
Family Ceratocampidae
Anisota senatoria S. & A.
Family Arctiidae
Hyphantria cunea Drury.
Family Noctuidae
Pyrophila pyramidiodes Guenée
Apatela oblinata Sm. & Abb.
noctivaga Grote
populi Riley.
leporina Linn.
Raphia frater Grote
Catocala meskei Grote
relicta Walker
unijuga Walker
parta Guenée
amatrix Hübner
Family Notodontidae
Datana angusii G. & R.
Pheosia dimidiata Herrich-Schaeffer.
Gluphisia septentrionalis Walker.
Hyperaeschra stragula Grote.
Schizura concinna Sm. & Abb.
Harpyia borealis Boisd.
Melalopha inclusa Hübner
strigosa Grote.
albosigma Fitch.
apicalis Walker.
Family Liparidae
Hemerocampa leucostigma Abb. & Sm.
Notolophus antiqua Linn.
Porthetria dispar Linn.

Family Lasiocampidae
Tolype velleda Stoll.
Malacosoma disstria Hübner
Family Geometridae
Metanema quercivararia Guenée
Cleora cribrataria Guenée
Lycia ursaria Walker
Sabulodes transversata Drury
Family Psychidae
Thyridopterix ephemeraeformis Haworth
Family Megalopygidae
Lagoa crispata Pack.
Family Gelechiidae
Anacampsis rhoifructella Clemens.
Pyrausta rubricalis Hübner
Phlyctaenia helvalis Walker
Family Oecophoridae
Phyllocnistis populiella Chamb.
Cryptolechia quercicella Clems.
Family Elachistidae
Batrachetra salicipomonella Clems.
praeangusta Haworth
striolata Zeller
Coptodisca sp.
Family Tineidae
Lithocolletes populiella Chamb.
Proleucoptera albella Chamb.
Gracilaria populiella Chamb.
stigmatella Fabr.

Coleoptera.

Family Chrysomelidae
Melasoma scripta Fabr.
Chrysomela pallida Say.
Crepidodera helxines Linn.
Xanthonia villosula Mels.
Family Scarabaeidae
Cotalpa lanigera Linn.

Hymenoptera.

Family Tenthredinidae
Pteronus ventralis Say.
populi Marlatt.
Cimbex americana Leach

BORERS.

Lepidoptera.

Family Cossidae.
Cossus centerensis Lintner
undosus Lintner
Prionoxystus robiniae Peck
Zeuzera pyrina Linn.
Family Sesiidae
Memythrus dollii (var.) castaneum Beuten.
tricinctus Harris
robiniae Hy. Edw.
Aegeria apiformis Clerck
tibialis Harris
Family Tortricidae
Subfamily Olethreutinae
Eucosma sp.

Coleoptera.

Family Buprestidae
Dicerca prolongata Lec.
Buprestis fasciata Fabr.
Agrilus granulatus Say
Family Lampyridae
Eros coccinatus Say
Family Cerambycidae
Plectrodera scalator Fabr.
Prionus laticollis Say
Hyperplatys aspersus Say
Mecas inornata Say
Saperda calcarata Say
moesta Lec.
concolor Lec.
vestita Say
Oberea schaumii Leconte
mandarina Fabr.
tripunctata Swed.
Family Curculionidae
Dorytomus mucidus Say
Cryptorhynchus lapathi Linn.
Family Calandridae
Wollastonia quercicola Boheman

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The Relation of Forests to Soil and Climate.

PROF. WILLIAM R. LAZENBY.

An inheritance is something that comes to us without any special effort or cost on our part. There are many kinds of inheritances. Some of them are personal or private, and some are of a more general or public character. For example, not a few of us have inherited a good constitution, and to this, together with reasonable care on our part, we are indebted for a full measure of good health. Some of us have inherited a good temper and to this we are indebted for much of the satisfaction and enjoyment of life. Some of us have inherited morals and some money. Few are so fortunate as to have both, and some have little or none of either.

Perhaps the greatest public inheritance of which we can boast is that of a *rich and fruitful climate*. Do we ever fully realize what an inheritance we have in our climate? Probably there is no place in the world where so great a variety of products for the comfort, convenience, and welfare of mankind can be so successfully grown as in the central and eastern portions of the United States. When we consider the number and nature of the different varieties of orchard fruits, garden vegetables, cereal grains, grasses, root-crops, forest-trees, shrubs, flowers and ornamental plants that can be grown surely and thriftily over a large part of the Central U. S. States, we are forced to admit that the

possibilities of our climate are equal if not superior to that of any other portion of the earth's surface of like area.

In some sections our summers may be too hot, and our winters may seem too cold for personal comfort; our growing season may appear too short, and the period of rest seem all too long for the best results in vegetable growth, and yet these very conditions favor the rapid and certain development of many of the best products of the farm, orchard, garden, and forest.

The climate of Great Britain and Ireland is more equable than that of this country, the severe heat and intense cold that we experience are there unknown; yet they can not raise our staple agricultural crop, Indian corn, and many of the finer fruits and vegetables of the orchard and garden are only grown with great difficulty and at no little expense. If we go to the tropics where nature seems more lavish, and where the needs of man are much less, we note the absence of our best fruits, grasses, timber trees, cereal grains, and root-crops. Tropical products are grown with less labor, but they are nothing like so valuable on the whole as the products we can raise right here in the Central United States. Surely we have a great inheritance in our climate. Are we guarding this inheritance as we ought? Are we not squandering it by the reckless destruction of our forests?

In the early history of our country, forest trees were obstacles to be overcome, — enemies to be annihilated. Having by rugged toil and painful effort subdued the forests, it seems like turning a short corner to begin to replant or renew what cost so much time and labor to remove. To clear the land for building sites, roads, and farms has been accepted as a necessity. The land was practically worthless until it was so cleared. The work was rugged and grimy, but healthful and beneficient. But when the best areas for tillage were denuded of trees, and cleared land was no longer needed to meet any of the various demands of civilization, the work of *devastation* began; noble trees were slashed down most imprudently for the mere pittance that the small part of the best of each would bring. After the ax had done its injurious work, fire followed in its trail, and even yet our country is not fully liberated from its baleful sway.

Take our own state of Ohio. Probably no state in the Union was supplied by nature with a more varied and generous covering of forest trees. For a little more than one hundred years this magnificent forest area has been yielding to the demands of agriculture, manufacture, and commerce.

At first these demands were legitimate, and in meeting them Ohio became one of the best agricultural states in the Union. It is a great stock and grain raising, milk-producing, fruit-growing, truck farming commonwealth; a state centrally located and one wherein land can be cultivated as profitably as almost anywhere else in the Union. For the past twenty-five years the total area of cleared land has increased at a rapid rate, but the aggregate production has diminished; in other words, the present total tillable area of the state is producing very little more than three-fourths of the same area did a few years ago.

I do not believe that it has been fully demonstrated that the average annual rainfall has been materially lessened, or its distribution greatly modified by the removal of our forests. But we do know that our soil rapidly loses in summer moisture, that our springs and wells are failing, our streams and rivers are more capricious in their flow, our drouths are more severe, and floods are more common.

We know that if all our hillsides and ridges, our ravines and rugged acclivities, the banks of our ponds, streams, etc., were bounteously wooded once more, we should not have so many failing springs, dry streams and low rivers, injurious floods, destructive winds and killing frosts. There would be less injury by washing and soil erosion. We should have more birds to charm us with their song and aid us in our warfare against devastating insects. I believe we could keep more stock, produce more milk and meat, raise more grain and grass, more fine fruit and delicate garden vegetables on three-fourths of the land now used for this purpose, if the other fourth was covered with timber. I feel certain that the slopes of many a hill in Southern Ohio, whose crests are well wooded, will yield larger average crops than hill side and top together where both are bare of trees.

While we have been cutting down our forests most improvi-

dently, developing a tree-destroying instinct, France, Germany, and other countries of Europe have declared that trees must be protected by the State and have formulated into law the lessons taught by a long and costly experience.

This experience shows that from one-fourth to one-third of any considerable area of any country should be occupied with trees, "and thus secure the best results in the productiveness of the soil and consequent ability to support a large and constantly increasing population."

Where stands Ohio in this respect? What is the ratio at present between the wooded and the cleared portions of this State? While the statistics are not so complete as we might desire, it is safe to say that the proportion of virtual timber land is not more than one-tenth of the total area, and the work of destruction still goes on.

New York, Pennsylvania and other states are awakening to a realization of the value of their forests. All civilized nations of Europe have long since enacted laws for the preservation of trees and for the re-establishment, in part, of the original forest area. Shall the great State of Ohio be blind to her further welfare? Shall we by short-sighted selfishness and negligence destroy this magnificant inheritance of soil and climate? Shall we devastate our fair commonwealth by flood and make it a desert by drouth? Shall we make our State a prey to tornadoes and cyclones, and see fruitfulness blasted by untimely frosts and hail? Is there any crime against Nature that draws down a more certain and terrible penalty than that of stripping the earth of all her forests? We do not object to the removal of forest trees after they attain their highest market value, nor do we expect the farmer to give up his most productive land to the raising of a crop of timber which may take a half century or more to mature. All that the friends of the forests ask is that all the land that cannot be cultivated or is now cultivated at a loss, shall be set apart for tree growing, and for every tree cut down at least two better trees shall be planted and reared until one-fourth of the area of the States is reclothed with trees.

We are confident that a large majority of our farmers would

improve their circumstances, and increase their income by concentrating their efforts and applying their labor and fertilizers upon three-fourths of the area they now too often skim and skin, by giving one-fourth back to timber-growing.

We know that Spain, Italy, portions of France and other countries of Europe have long suffered and are now suffering from the reckless improvidence that destroyed their forests. Shall we repeat and parallel by our own ignorance and selfishness the same mistake? Shall our noble country bear witness to a like recklessness and improvidence?

I suppose there are few who have failed to realize in some measure at least the important part played by forest trees in the economy of nature. Yet the question as to the general effect of trees upon soil, climate, and our economic condition as a nation, is one that has not always presented itself to our minds as demanding a practical solution.

Considered from a strictly utilitarian point of view the necessity for prompt and liberal measures to restore and preserve our remaining forests is urgent and pressing. The prevention of injurious floods and subsequent periods of drouth, of untimely frosts and destructive winds, the abundance and purity of our water supply for towns and cities, the control of insect enemies, the failure of crops from lack of moisture, are vital questions.

When we consider the enormous drafts made upon the forests of this country by the constant and pressing demand for wood, we may well be concerned regarding the future supply. The forests of Ohio were a grand inheritance, that should have been regarded and managed as a sacred trust. It is neither fair, nor honorable, to squander it.

To make timber plentiful, we must in the first place preserve and improve our *existing woodland.* Second, we must reclothe all rugged broken land, all rocky crests, and steep hillsides, every acre that is not cultivated, or is cultivated at a loss with valuable forest trees.

The proportion of the whole area of the State of Ohio that should be constantly and forever devoted to trees is not less than

one-fifth. Not more than one-tenth of the State is now occupied with trees and the work of destruction still goes on.

In order to preserve, improve and extend our forests, and make them really valuable for their timber product, we must keep up a constant succession of young growing trees of the best varieties.

To do this it is necessary to allow no stock to run in wood lots for the purpose of forage. This should be a rule inflexible and relentness. All existing woodland that is covered with a thick growth of underbrush, should be thinned moderately and judiciously. Worthless varieties should be removed, while the more valuable sorts should be trimmed up so that they may grow tall, forming trunk rather than branches.

For whatever purpose it may be planted or preserved, we should not forget that a good tree grows just as thriftily, and as surely, as a poor one.

It is wretched economy to preserve every tree good, bad, or indifferent that may happen to be growing upon our land; but until we see about one-fifth of the ground occupied it should be our aim to rear at least two good trees for every one cut down.

The problem of forestry in Ohio will be solved when every farmer has a well managed, increasingly valuable wood lot. I feel sure that there are few farms in Ohio so small that a portion of each might not be profitably devoted to the growing of valuable trees, and I know of none so large that its owner can afford to grow indifferent or practically valueless varieties where choice timber can be grown as well.

I am not troubled with any mawkish sentiment regarding the cutting down of trees. Usefulness should be the end, and utility the reason for promoting all vegetable growth, whether it be the herb of the field or the monarch of the forest.

Tree should exist for use, and I urge the preservation, improvement and extension of our forests because I believe it will pay.

Let me close with the thought with which I began. Do we owe nothing to posterity? Is it not our duty as the inheritors of a great trust, our soil and climate, to preserve this grand

inheritance and transmit it unimpaired to those who come after us? Have we any right to simply skim and skin our soils, or to make a fruitful climate unfruitful? Have we any right to impoverish our soil by drouth or flood or erosion? Are we doing the honorable, the manly thing, in compelling our children to buy timber at twice and thrice the cost at which we might and should have grown it? Let us think of these things.

Why Should the Horticulturist Keep Bees?

ARTHUR H. M'CRAY.

To any one who has studied this question the fact seems to be self-evident, that the horticulturist will not only find bees a benefit, but in many cases a necessity, as will be shown by testimonies of prominent horticulturists, and statements and conclusions from eminent scientists. In order that a blossom may develop and set fruit there must be a union of male and female elements, or pollen must unite with the ovule or undeveloped seed. Every one knows the result when a stalk of corn is removed from all other growing corn, and the tassel cut from this isolated plant.

In order to get a somewhat better understanding of the origin and development of fertilization we quote from that admirable book, The Fertilization of Flowers, by Prof. Hermann Müller. He says: "Even in the lowest algae we find cross-fertilization, to effect which, two individuals move towards each other in the water by means of a cilium. In a higher grade we find the two individuals differentiated, one losing its motility and increasing in size to form an ovum, while the other (sperm cell or antherozooid) retaining its primtive motile form, swims about in quest of the ovum. This mode of cross fertilization is retained not only by all cellular cryptogams (except the Florideae or red seaweed, whose tailless antherozooids are moved passively in the current) but also by all vascular cryptogams. With the change

to dry localities where even occasional moisture sufficient for the migration of the antherozooids is not attainable, the vascular cryptogams seem to have developed wind fertilized unisexual flowers, thus first the Gymnosperms, and from them afterwards the Angiosperms have arisen. Finally from the wind fertilized Angiosperms, entomophilous (i. e., insect-fertilized) flowers arose as insects came first accidentally, and afterwards regularly to seek their food on flowers, and as natural selection fostered and perfected every change which favored insect visits and thereby aided cross-fertilization." We have quoted at length from Müller because he illustrates so admirably the evolution of our insect-pollinated plants. Having now arrived at the point where plants are insect-pollinated, let us see what insects take part in this, and the ratio of insect pollinated plants to those otherwise pollinated. That eminent scientist, Charles Darwin, devoted many years to the study of fertilization, and embodied the results in a book of about 500 pages entitled, Cross and Self Fertilization in the Vegetable Kingdom. On page 441 he says: "The possibility of cross fertilization depends mainly on the presence and number of certain insects, often of insects belonging to special groups, and on the degree to which they are attracted to the flowers of any particular species in preference to other flowers; all circumstances likely to change." On page 370 he says: "The most important of all the means by which pollen is carried from the anthers to the stigmas of the same flower, or from flower to flower, are insects belonging to the orders of Hymenoptera, Lepidoptera, and Diptera." Let us see now if we can determine which one of these groups is the most important. Hear what Müller says upon this phase of the question: "Bees (Apidae) are the most skilful and diligent visitors, have played the chief part in the evolution of flowers; we owe to them the most numerous, most varied, and most specialized forms. Flowers adapted for bees probably surpass all others together in variety of color. The most specialized, and especially the gregarious bees, have produced great differentiation in color, which enables them on their journeys to keep to a single species of flower." It must be understood that Müller is here speaking of the great group Apidae which comprises many

different kinds of bees. Now as to the amount of this pollination which the honey bee (Apis mellifera) performs, we cannot perhaps speak quite so definitely as we can for the group Apidae as a whole, but we believe that in the testimonies given later on in this paper, from prominent horticulturists, and experimentalists, it will be shown that the work of this little insect is in some, perhaps many cases, absolutely indispensable. Prof. Norman B. Waite, of the Division of Vegetable Pathology of the Dept. of Agriculture at Washington, D. C., in a bulletin on Pollenation of Pear Flowers, has this to say: "Incidental mention has been made of insect visitors. We should not proceed without laying some stress upon the importance of these visits. The common honey bee is the most regular, important, and abundant visitor, and probably does more good than any other species." The subject of cross and self-fertilization is a very broad one, and not much can be said here, except that it is highly probable that some great advantage is gained by plants of crossed parentage over those of self-fertilized parentage. This advantage may lie in superior growth, vigor, and fertility of the cross- fertilized plants. Darwin took measurements as to height, and comparisons as to weight, and fertility, of fifty-seven species of plants, belonging to fifty-two genera, and thirty great national families, showing the ratio between cross and self-fertilized plants, also between the offspring of plants that were intercrossed for several generations, and then crossed by a fresh stock. According to his tables, showing the results of these experiments, the self-fertilized plants rate in some cases as low as 3. Thus in the plant Mimilus luteus, the offspring were self-fertilized for eight generations, and then crossed by a fresh stock, and the cross-fertilized, compared as to height, weight, and fertility with the self-fertilized, as 100 to 3. And so the fruit grower, before he knew the reason why, had found out that certain varieties of fruit would not do well when planted, isolated from all other varieties, or if rain occurred through blossoming time, and so on for other causes. And the question may be raised as to whether the honey bee as a fertilizing agent has been duly appreciated. Let us see what some prominent horticulturists from various sections of the country have to say

upon this subject. In Gleanings in Bee Culture for 1894, issues of Jan. 15 and Feb. 15, there appeared a symposium on the subject of Bees as Agents in Fertilizing Fruit Blossoms, and the same is published in part in Root's A, B, C of Bee Culture, from which we now draw a few extracts and quotations. In this symposium Mr. J. F. McIntyre, an extensive bee-keeper of California, was a delegate to the State Fruit Growers' Association, and reports that a gentleman stated that he had a friend in the State who started into fruit growing several years ago, locating 35 miles from any fruit-growing section, or from proximity to any place where bees were kept. The first year that his trees blossomed, a complete failure of fruit resulted. On being advised to procure some bees to aid in fertilization he did so, and since then the orchard has been productive. Chas. A. Green, in the Fruit Grower, published in Rochester, N. Y., writes that it is now demonstrated that many kinds of fruits, if not all kinds, are greatly benefited by the bees, and that a large portion of our fruit, such as the apple, pear and particularly the plum, would be barren were it not for the pollinating agency of the honey bee. Prof. Waite, of Washington, D. C., has experimented along lines which may be tried by almost any one with a little patience and care. He covered blossoms of pear and apple with netting, excluding the bees, and found that in a great many cases no fruit would set, because the bees were unable to reach the blossoms and disseminate the pollen in their search for honey. Mr. Green says that the fruit-growers of the country are greatly indebted to Prof. Waite, and that the lesson is, that fruit-growers must become interested in bees. While Prof. Waite has no doubt done much to show the practical bearing of such insect exclusion, it must not be forgotten that Darwin carried on extensive experiments in excluding insects from plants, in order to test the effect upon fertilization. Darwin used 125 plants in his experiments, 65 of which, or over half, were sterile without insect aid.

An interesting testimony in this symposium, coming back to this again, was from Mr. F. A. Merritt, of Andrew, Ia. This gentleman tells of his apple orchard situated in such a way that it is exposed to both north and south winds, and states that one

year the trees on the south row (Transcendenteral, which throws out a heavy growth of foliage at the same time that it blooms) began to open their bloom at the time that a heavy south wind commenced to blow, and which lasted for five days. It was noticed that during this period the bees could not touch the bloom on the south side of the trees, but that they worked in numbers on the sheltered limbs on the north side. The result was, that the north side was well loaded with fruit, while on the south side scarcely an apple was to be seen.

In the spring of 1892, the late Allen Pringle, of Shelby, Ontario, one of the leading bee-keepers of Canada, was summoned to appear before a legislative committee of the House of Assembly of Ontario, to give expert testimony as to the agency of bees in scattering pollen. The Minister of Agriculture summoned not only the leading bee-culturists, but also those engaged in growing fruit, and in addition to this, the scientiists were also summoned from Ottawa and Guelph. Mr. Pringle states that the horticulturists with one single exception, admitted the valuable and indispensable offices performed by the honey bees, in the fertilization of fruit bloom. This was corroborated and confirmed by the entomologists, and Prof. James Fletcher, the Dominion Entomologist, said that in dull weather the bees did not visit the fruit blossoms and as a result but little fruit was secured. The writer was interested to learn that the Experiment Station at Rhode Island has an apiarist on its staff, and in Bulletin No. 4, Dec. 1889, devoted entirely to the subject of Bee-keeping, testimony is given as to the value of bees in fertilizing fruit-blossoms. Mr. James A. Budlang, of the firm of James A. Budlang & Co., at Cranston, and who has grown cucumbers as a specialist for 40 years, being the largest market-gardening firm in the State, if not in New England, says that he would as soon try to raise a crop of cucumbers without water and manure as without bees in a closed greenhouse. Without them he says there would be no crop, the plants all running to vines, and the blossoms and small cucumbers dropping off on the ground. With open windows he would expect part of a crop. He always places hives of bees in the green-houses when the vines bloom. Furthermore he says

that for out-door crops, such as cucumbers, squashes, and pumpkins, bees are necessary, although the wind does some of the work.

Prof. A. J. Cooke, formerly of the Michigan Agricultural College, but now in California, says that while there are solitary insects which aid in pollination, yet the work which they accomplish is infinitessimal as compared with that of the bees, because the hony-bee lives over the winter, and is on hand in spring when the first fruit bloom appears.

Prof. Asa Gray, the distinguished botanist, says that we cannot resist the conclusion that the aid of insects is so to say counted upon, so that blossoms are furnished with honey in order that they may attract insects.

Enough has been said to show the advantage of the cross-fertilized over the self-fertilized plant, and the honey bee as no other agent perhaps, accomplishes thi very much desired cross-fertilization. The extraordinary industry of bees, and the great number of flowers which they visit in so short a time, each flower being visited many times, very greatly increases the liability of plants receiving pollen from a different plant, of distinctly different characteristics, which is just what is desired. Darwin says that bees are good botanists, for they will visit on a single honey gathering expedition plants only of one species* even though it has a different color, and yet Darwin proved to his satisfaction that bees could distinguish colors, and even goes so far as to tell us that bees have a remarkable memory. But we digress, and the point is that bees by their frequency of visits to flowers in so short a time bring about the most desirable mingling of pollen. In fact bees work so industriously and effectually that even in the case of social plants where hundreds of thousands grow together, as in the heaths, every flower is visited and no doubt visited many, many times.

* It must not be supposed from this that bees always confine their visits to a single species, for if plants of a particular species are scarce, they often visit other species.

The Composition of Eight Varieties of Grapes Found on the American Market.*

E. I. LICHTI.

The varieties of grapes used in these analyses were purchased from the market in Columbus, Ohio, in the months of September and October, 1905. At this season of the year, large quantities of grapes were shipped in baskets or boxes from the grape growing regions to the various cities of the United States, to be used very largely for dessert. One of the most important regions is in the vicinity of the Great Lakes; here, in the central lake region of the State of New York and along the shore of Lake Erie in the State of Ohio, grapes are grown extensively both for wine and dessert. The other important region is in the State of California along the Pacific coast.

The leading varieties of the Great Lake region belong to the native species of grape, while those of California have originated from the European species. The skin of the native grapes separates readily from the flesh; but in the European varieties, the skin and flesh adhere. Of the varieties mentiond in these analyses, the Concord, Niagara, Delaware, and Catawba belong to the native species and were shipped from the State of York; of the varieties belonging to the European species, the Emperor, Morocco and Tokay, came from California, while the Malaga was imported from Europe. With the exception of the Morocco, these eight varieties represent the leading and most popular grapes from a market point of view.

Since the great regions of grape production are few and rather definitely marked and their shipments are so widely extended, an analysis of even a retail sample having its origin in such a region will in a general way be representative of the product and will serve to give a conception of at least the general composition of the grape and the importance of the food dietetic

* Extracts from a thesis presented as part requirement for the degree of Bachelor of Science in Horticulture and Forestry at the Ohio State University, 1906.

and economic value of the thousands of people who are its consumers.

TABLE OF ANALYSES.

VARIETIES OF AMERICAN SPECIES.

Constituents.	Concord.	Niagara.	Delaware.	Catawba.
Water	84.05	82.48	81.92	81.39
Sugar	10.00	10.46	10.20	8.60
Free Acid (1)	1.42	0.90	1.19	2.02
Ether Extract	0.45	0.57	0.74	0.87
Protein (2)	0.76	0.71	0.94	0.97
Fiber	0.33	0.52	0.57	0.59
Pectose	0.28	0.35	0.22	0.68
Seeds	2.25	2.41	3.15	3.53
Ash (3)	0.46	1.60	1.07	1.35
Total	100.00	100.00	100.00	100.00

VARIETIES OF EUROPEAN SPECIES.

Constituents.	Emperor.	Malaga.	Morocco.	Tokay.
Water	80.90	82.28	82.11	73.99
Sugar	13.40	13.20	11.60	21.00
Free Acid (1)	0.52	0.45	0.45	0.45
Ether Extract	0.35	0.20	0.28	0.46
Protein (2)	0.75	0.70	0.95	0.76
Fiber	0.48	0.34	0.34	0.23
Pectose	1.12	1.98	2.00	1.10
Seeds	1.87	0.41	1.83	1.19
Ash (3)	0.61	0.44	0.44	0.82
Total	100.00	100.00	100.00	100.00

(1) As tartaric acid; (2) Exclusive of protein of seeds; (3) Exclusive of ash of seeds.

REMARKS ON TABLE OF ANALYSES.

It will be of interest to compare the persentage of some of the more important constituents in the different varieties.

Seeds. — For instance the seeds are a waste in the use of grapes and hence the less seeds there are, the more desirable the variety would be. The American varieties have a higher percentage of seeds than the European varieties. The percentage ranges from 2.25 in the Concord to the 3.53 in the Catawba, and from 0.41 in the Malaga to 1.87 in the Emperor. On the average the American varieties have twice as many seeds as the European varieties. From the standpoint of seeds, the Concord would be the most desirable American variety, and the Malaga the most desirable European variety.

Free Acid. — The amount of acid would be of great importance to wine producers, for a grape with a low percentage of free acid and a high amount of sugar is much better for the production of wine than one high in free acid and low in sugar. Then also in food diet, much importance is attached to the fact that the acid of fruit is quite beneficial to the system, and in the case of certain individuals, the use of fruit is of special benefit to their health; and it is safe to say that the majority of people would be benefited by a liberal use of fruit. The medical profession might be able to make some practical use of a table of analyses showing the different percentages of acid in our fruits. The table shows that the American varieties are higher in free acid than are the European varieties, the American varieties having on the average three times as much as the European varieties. The percentage of free acid ranges from 0.90 in the Niagara to 2.02 in the Catawba; and from 0.45 in the Malaga, Morocca, and Tokay, to 0.52 in the Emperor.

Sugar. — The sugar as already mentioned is of importance in the production of wine. It is also of value as food, hence the higher the percentage of sugar, the more desirable the grape would be. The percentage of sugar ranges from 8.60 in the Catawba to 10.46 in the Niagara, and from 11.60 in the Morocco to 21.00 in the Tokay. On the average, the European varieties

have one and one-half times as much as the American varieties. It will thus be seen that the European varieties are more valuable for the production of wine than the American varieties.

Ether Extract. — This is mostly composed of fat. While fat is useful as food, it will be seen that the percentage is low in the grapes. It ranges from 0.45 in the Concord to 0.87 in the Catawba, and from 0.20 in the Malaga to 0.46 in the Tokay. The American varieties rank highest, having on the average twice as much as the European varieties.

Protein. — This is also valuable as food but is low in percentage. It ranges from 0.70 in the Niagara to 0.97 in the Catawba, and from 0.70 in the Malaga to 0.95 in the Morocco. It will be seen that the percentage of protein is practically the same in both the American and European varieties.

Summary. — The seeds, free acid and sugar are of most importance from the standpoint of wine production, food, and diet. Briefly summarizing then, the American varieties are high in the percentage of seeds and free acid, and low in sugar; the European varieties are low in seeds and free acid, and high in sugar.

Protecting Crops From Frost.

PROF. J. WARREN SMITH.

Frost is formd when the water vapor is condensed out of the atmosphere at a temperature near or below the freezing point of water.

The damage done by frost in Ohio, especially in the spring of the year, is often very great. Early garden crops, strawberries, raspberries, plums, and even the larger fruits and field crops are frequently injured.

Forecasts of freezing weather and warnings of expected frosts are widely distributed by the United States Weather Bureau by mail, telegraph, and telephone, and through the daily press. The weather forecasts that appear in the morning papers

are based on the evening observation before and are issued from the Washington office through the press associations.

The forecasts that appear in the evening papers are based on the morning observation and are widely distributed. They are telegraphed at Government expense to places that can make a further distribution by mail or telephone for public benefit. They will be sent by mail to any person who can be reached from one of our distributing points on the day of issue.

These forecasts and warnings are distributed most widely, in Ohio, by telephone. There are about 800,000 telephones in the State and the plans now in operation will enable the owners of over 400,000 of these to secure the forecasts for the coming night and next day, by calling up their "Central." This information can be obtained between 10:00 a. m. and 11:00 a. m. Frost warnings are distributed in the same way, and arrangements will be made to telegraph the warnings at Government expense to any community where action will be taken to make general use of the information.

In California and in the extreme south plans have been perfected for protecting orange groves and garden crops. The Montgomery, Ala., Advertiser of March 5, 1904, states that a recent warning had saved $50,000 or more to the truckers of that vicinity. The New Orleans Picayune of December 29, 1904, said that one freeze without warning in that State would mean the loss of many thousands of dollars and perhaps millions. And also that so accurate and definite have the warnings become that no planting interests in the State have suffered if warnings are received and action taken to protect.

If crops can be protected from cold waves and frosts in these states there is no good reason why they cannot be protected in Ohio, with a little careful planning. Every fruit grower knows that if he can have a good crop when the average crop is small he is sure of a good market. And every gardener knows that the earlier the crop the better the price. It seems then a wise plan to take some steps to protect early truck crops, strawberry fields, or orchards against a late freeze or frost.

I shall be glad to attend any local horticultural society meet-

ing and explain methods for frost protection or to visit any community and give personal advice in regard to locating fires, etc., if my expenses are paid from Columbus.

CONDITIONS FAVORABLE FOR FROST PROTECTION.

1. Clear skies. Because radiation of heat is rapid under a clear sky.

2. With dry air, because the drier the air the lower the temperature will fall before the dew point is reached and condensation take place. For then the further fall in temperature is checked by the latent heat released by condensation. The condensation of enough vapor to make a pint of water will evolve enough heat to raise more than five pints of water from the freezing to the boiling point.

3. Nearly still air, because under these conditions the air arranges itself in layers according to its density, and the colder, denser air collects near the surface and in low places.

METHODS OF PROTECTION AGAINST FROST.

1. Diminishing the radiation of heat.
2. Raising the dew point of the air.
3. Adding heat to the air.
4. Mixing the air so as to prevent its forming in layers.
5. Draining the cold air away from the section that needs protection.

The surface of the earth and the objects upon it are warmed in the daytime by radiant energy from the sun. The atmosphere is not warmed much from the sun, but the air directly in contact with the warmed ground is itself warmed by the conduction of heat from the ground to it, and this warmed air, expanding, is carried away by convection and in turn warms other parts of the air.

At nighttime this heat stored in the surface of the ground is radiated into space, the air in contact with the cooled ground looses part of its heat by conduction to the cooler earth, and as more and more heat is radiated, the air near the earth gets colder

and colder until under favorable conditions the freezing point is passed.

Dark colored objects radiate heat more rapidly than light ones. Dark colored soil will be from 6 deg. to 14 deg. colder during a cold spell than a light colored soil. The temperature over a dark colored lawn has been found to be 1½ degrees lower than over a light colored lawn.

The texture of the soil has some effect on the radiation of heat also. The temperature over a dark colored muck was found to be 1½ higher than over a lighter colored loam, but 2 degrees lower than over a very light clay. This would make the temperature over a loam 3½ degrees lower than over a light colored clay.

Cultivated soil does not loose so much heat as uncultivated soil; the difference as observed, amounts to 3 degrees. It is thus a distinct advantage to cultivate crops when a frost is expected

Objects upon the surface of the earth lose heat at night by radiation, but they gain heat by conduction from the ground. Grass and growing crops cannot obtain so much heat from the earth by conduction as they lose by radiation at night.

Thus the temperature in grass 6 inches high has been found to be 10 degrees lower than over bare ground, and in clover 2½ inches high, 4 degrees lower. Frost is usually seen on a board walk or the roof of a shed because they lose heat rapidly by radiation, and can receive very little by conduction, even less than grass can receive.

The fact that frost is so frequently seen on the roof of sheds has led some to think that the lowest temperature is some 10 to 20 feet above the surface of the ground. Not so. The coldest air is nearest the surface of the ground, and when cooled by conduction to the colder ground it becomes more dense and slides down into the lowest places.

Tender plants then should never be put down in the lowest spots, but up on the slope.

Any covering then will effect the protection indicated by method No. 1. Glass screens are used in green houses and hot beds. Cloth screens are used in France and are stretched over large tracts on wires. Laths are fastened to telephone wire, with

the space between the laths about the width of a lath, and are laid over orchids in California and Florida. Along the lower delta of the Mississippi the owners of orange groves actually house in acres of the groves, and in Florida they have built cloth or board houses around each tree.

Strawberries are very successfully protected by turning the mulch up over the plants, and cabbages by throwing a handful of hay on the windward side. Potato plants have been protected by plowing a furrow over them, and cranberries by turning water over the fields.

When it is cloudy very little heat is lost by radiation, therefore crops have been successfully protected by covering them with a smoke or smudge. If damp material is burned moisture is added to the air and the second of the protective conditions is met, i. e., raising the dew point of the air so that the condensation of moisture may take place above the freezing point. And not only this but any fire will also aid in carrying out both the third and the fourth methods for protection also.

Damp smudges may be made by burning numerous small piles of damp straw and stable manure. Or manure may be packed into grain or burlap sacks. They should be distributed through the orchards in rows about 100 feet apart and about 50 feet apart in the rows. When it is found necessary to protect the crop a small amount of oil is poured onto each sack and ignited. These sacks will burn with a smoldering fire for several hours. It is usually not necessary to light more than every third or fourth sack at first.

The amount of heat which is set free by burning one sack of manure weighing about 50 pounds, and condensing the vapor near the surface, would be sufficient to raise the temperature 20 degrees in a space 75 feet square and 25 feet deep. If one-fourth of this heat remained within the region needing protection, which seems a reasonable estimate, ample protection would be obtained for almost any ordinary condition. Bales of wet straw is sometimes used also.

An even better plan is to build a smudge fire upon some low wagon or sled and have it drawn about the orchard or garden.

Several devices have been used, but the simplest is to heap damp straw or manure on chicken-netting fencing and stretch it from four wagon stakes, then set pots of burning tar or some other fire under this straw. A barrel of water is set on the wagon to keep the straw wet. The smoke and vapor are carried to the rear as the wagon moves along, and, being carried at once out of the rising heat, it falls close to the ground in a long, white trail. The wagon can be drawn about where most needed, and one man can in this way protect many acres.

In one case in California four of such sleds and 500 sacks of manure saved 300 acres during a six nights' freeze. The estimated cost was less than 1 per cent. of the value of the crop saved.

In some instances it has been found practicable to add dry heat to the air by burning coal in wire baskets. From 20 to 40 of these baskets costing from 7 to 10c each, are scattered over each acre, filled with coal and burned as needed. The cost of the coal is only about $2 to $3 per acre, and it has been found possible to raise the temperature of the air from 3 degrees to 5 degrees throughout the orchard.

It is thoroughly practical to protect an orchard of navel oranges worth $400 per acre by this small expenditure, and it seems just as practicable to protect strawberries or other crops worth even more than that.

Farmers' Bulletin No. 104 gives detailed instructions regarding frost protection. Each fruit grower or gardener should secure a number of thermometers, and study the air drainage and frost conditions of his own farm, and should take steps to obtain the frost warnings of the Bureau and protect his crops. We shall be glad to aid by personal advice and visits so far as possible.

Insects Affecting Willows.*

R. W. HARNED.

In this country the willows are usually considered as among our least important forest trees, although in Europe they are valued more highly. For centuries they have had important economic uses and as our forests continue to decrease in size, their importance will continue to increase, as they are rapid growers, especially in damp places, and in this respect are excellent trees to plant at the heads of streams and along their banks.

The willows are widely distributed over both continents, but are found most abundantly in temperate regions. Writers have mentioned them from the earliest times. Pliny states that the Britons made voyages in boats of willow. The ancients used willow wood in the making of shields, because it will indent without breaking. The greatest economic value of the willow is in the basket-making industry, and people of all ages and all continents have used it for this purpose. In most European countries willow growing is a large industry. The European farmers grow it annually, many of them considering it their most important crop. In this country, willow growing is developing rapidly, and in certain sections of Maryland and New York particularly, it has become one of the leading crops.

Willow makes the very highest grade charcoal, which is used especially in the manufacture of the finer kinds of gun powder, as it ignites very readily. The bark is used extensively in the tanning industry. Salicylic acid is obtained from this wood for

* This paper consists of extracts from a thesis prepared in the Department of Zoology and Entomology as part requirement for the degree of Bachelor of Science in Horticulture and Forestry at the Ohio State University.

The extracts have been selected first to include some of the original observations and studies, and second to present the facts gathered from various sources relating to some of the most serious pests of the willow. The thesis as a whole, deposited in the Department library, includes a record of all the known species affecting the willow with a full discussion of the life history, habits and remedies for the more important ones.

commercial purposes. Lazlett states that it is used for cart lining because it will not splinter when struck by stones. It has been used for cricket bats, keels, paddles, water wheels, lap boards, furniture, and because it resists heat and friction is used in lining friction brakes, and a host of other useful objects are manufactured from willow wood.

The wood is soft, has no grain, and is therefore of no importance for many purposes, but is tough, light, workable and elastic, expanding very slightly in water, and does not crack or splinter, and thus can be used when the wood of other forest trees is out of the question.

According to the census of 1900, there were in the United States 550 establishments manufacturing baskets and willow-ware, with a capital of about $3,000,000, employing 4,396 hands, paying $1,280,511 in wages, producing $3,851,244 worth of finished products, and paying $1,398,374 for the material consumed.

Willows grow very easily and rapidly, and are much desired along streams and rivers, as they hold soil intact and prevent erosion. On the prairies, as well as in other parts of the United States, they are largely used for hedges and windbreaks. As a fuel, they lead all other trees in some districts. In landscape gardening the willows have a firm hold; many of them, as the white willow, weeping willow, and shining willow are among our most ornamental trees, and are to be found whereever beautiful landscape effects are desired.

Willows are easily propagated by cuttings. Twigs snapped off by currents of water are washed ashore, take root and grow. The industrious Hollanders check the force of the great rivers of the Rhine delta by planting willows along their banks, and in this country the railroads have learned the great benefit of the willow to hold embankments, and are planting great numbers of these trees annually.

It is very evident that the willow is of economic value, and the study of its insect enemies is of some importance. In each case the writer has endeavored to give authentic references in the bibliography that refers either to the insects attacks upon the willow or to a description of some of its stages or life his-

tory. Although attacks of certain insects may be confined to certain species of the willow this is very doubtful, and in most instances it is found that insects attacking one species will also attack other species. In the case of gall-forming insects, they may possibly be confined to one or two species, but even this is very doubtful, and as there are so many hybrids and peculiar species as to render their classification difficult, the writer has not tried to make any distinction in the different willows. Some authorities give as high as one hundred and eighty species of willow.

ORDER COLEOPTERA.

Family Chrysomelidae.

The Spotted Willow Beetle. Lina lapponica Linn.

On the University farm and in the neighborhood of Columbus, Ohio, this insect was by far the most abundant and most destructive of all willow leaf feeders during the spring of 1906. They were so abundant that it was difficult to find a willow plant that did not have at least a few of these beetles. Many small trees were completely defoliated. The larvae are especially destructive. They eat very rapidly and it does not take a great many of them to cause all the leaves of a branch to look as though a frost had struck them. The adults eat around the edges of the leaves, sometimes eating the whole leaf, but usually moving from leaf to leaf, partially eating each one.

This insect hibernates in the adult stage, and the beetles are seen very early in the spring. They show considerable variation in markings and size. The body has a general dark color, varying from a very dark brown to a blackish purple. The antennae and legs are always dark, while the wing pads and dorsal part of thorax are always red and black, sometimes more red than black, but usually about evenly distributed. In every insect that was noted, the sides of the prothorax were brownish or light reddish, while usually the central part was black, but sometimes this is also partly red. Irregular bands of black and red running across the wing covers is probably the most common coloration, but these bands are often much broken, and

the proportion of the two colors varies much in different individuals. In some the wing covers are entirely red with two small black spots in about the middle of each wing pad. This variation is so great as to be easily taken for another species, but several of these were found copulating with those of other variations, so there is no doubt as to their identity.

In size this insect also shows considerable variation. As a general thing the females are larger than the males, but individual females may be smaller. A number of these beetles were bred in the laboratory from the eggs. Those that received plenty of food in the larval stage were much larger than those that were partly starved. In the same brood there is considerable difference in size among the larvae, some growing much more rapidly than others. This probably accounts for the great variations in size. In the laboratory after the larvae had been raised ten days on willow leaves, two were separated with only one small leaf for food supply. That leaf was soon eaten and the next day the larvae pupated, while the remaining larvae with a plentiful food supply did not pupate for several days. When the adults emerged it was found that those with plenty of food were somewhat larger than the other two.

The eggs for the first brood are deposited on the leaves of willow in masses of about fifty during April and early part of May. The eggs are yellow or greenish yellow, oval, about one-eighth of an inch long, and each one is fastened to the leaf. The eggs hatch in about a week, sometimes in less time, depending upon the temperature, and the young larvae develop rapidly. At first they are black and gregarious, skeletonizing the leaf in the immediate vicinity of the egg shells. With each succeeding molt the color becomes somewhat lighter, and they separate until when they are full grown they may be considerably spread over the tree or branch, and not more than one will usually be found on a leaf. These larvae have two spines on the dorsal side of the meso and metathorax. When disturbed they emit a milky fluid from these spines. This is probably for protection from other insects, but does not appear to have any disagreeable odor. They attach themselves to the leaf when full grown by the anal

prolegs and partly throw off the last larval skin and pupate. The adult beetles issue in about three days. The insect develops very rapidly and there could easily be at least half a dozen generations during a season, but there are no records of more than three or four. After the first generations, these insects do not appear to be so abundant, and they may be kept in check by birds, but this is doubtful. Several lady beetles were seen on leaves with the eggs and young larvae, and they probably destroy many of these insects.

Where these insects are serious, the trees may be sprayed with an arsenical poison, and as all the stages are spent on the plants, this should be very effective. In the west, London Purple has been used for the closely related species, Lina scripta.

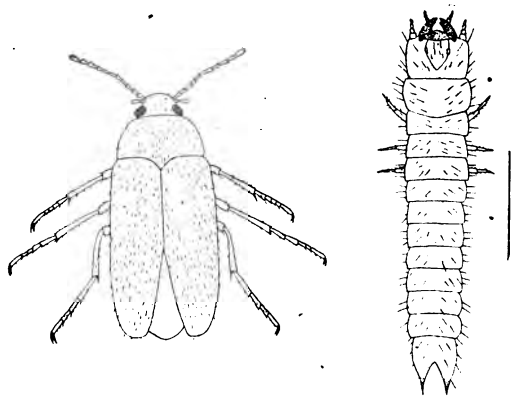
Family Melandryidae.

Synchroa punctata Newman.

Late in February, a number of the larvae of this beetle were obtained under the bark of a dead willow. The weather had been warm for several days and the larvae had probably thawed out and were boring through the wood just under the bark. Many of them were seen during the next three months, varying in size from one-tenth to over one-half inch in length. A dozen of those larvae were kept in a box in the laboratory for two months, each of them molting twice. Then several of them died, and by May 18th only two remained alive. On May 25th, one of these became an adult, having pupated during the previous week.

The fullgrown larva is about one-half inch in length and one-twelfth inch wide. The color varies according to the color of its food; sometimes it has a smoky grey color, but usually a bright yellowish color with brown mouth parts, and the tips of the posterior spines are also brown. There are thirteen segments including the head, all of which are about the same size except the first two, which have about twice the length of the others and are slightly wider. The second segment is the widest of all, while the head is the longest and largest segment. The

mouth parts are strong and well developed, are dark brown in color, especially the mandibles, which are nearly black in some cases. At the posterior end there are a pair of spines that project directly backward and curve upward. These spines run out to sharp points, which are dark brown. The whole body of the larva is thinly covered with hairs, while the dorsal side of the segments from three to nine have a peculiar punctured or mottled appearance when viewed under the magnifying glass. The antennae are four-jointed, conspicuous, and are in motion most of the time while the insect is moving. The palpi are also rather prominent.



Adult and larva of *Synchroa punctata.*

The adult beetle is dark brown, not quite as large as the larva. The entire body is densely covered with white hairs. The antennae are eleven jointed. The tarsi of the metathoracic legs are four-jointed, while on the other legs they have five joints. In each case the first joint is the longest. A pair of claws on the end of the last segment of each tarsus are curved. On the tibia there appears a pair of bristles at the joint where the tibia joins the tarsus. These beetles are probably not injurious, but some of them were found boring into fairly solid wood.

ORDER DIPTERA.

Family Cecidomyiidae.

The Pine-cone Gall. Cecidomyia S.— strobiloides Osten Sacken.

This is one of the most common and conspicuous willow galls. It occurs always on the tips of twigs and sometimes in great abundance, especially on the Heart-leaved willow (Salix cordata.) The gall has a remarkable resemblance to a pine cone, and is therefore generally known as the Pine-cone gall. It is a deformed and enlarged bud, the stem being so injured by the larvae of the insect that it ceases to grow, but leaves continue to develop, and thus the gall is formed. This is a monothalamous gall, the larva forming it remaining in a cell in the center throughout the summer and winter, pupating in the early spring. The adult emerges soon afterward. The exterior of this gall is covered with dense white pubescence, but this may largely disappear during the winter, leaving the cone a dark brown color, while the interior of the gall is reddish brown. Often the eggs of grasshoppers are found between the leaves of these galls and there are a number of inquiline flies that inhabit them also. The larvae of this insect do not differ noticeably from the larvae of the other gall-forming Cecidomyiae. They all have the characteristic breast bone between the second and third segment on the ventral side. In the summer and fall the larvae are white, but gradually turn to an orange color, and in the spring before pupating are deep orange. The pupae when first formed appear to be almost blood red in color, but this soon becomes darker until they are black before the adults emerge. The adults appear during April and May, depending on the temperature, and immediately lay their eggs in the young terminal buds.

Where numerous, these insects are quite destructive, as they check the growth of the twigs, but they are not easily destroyed. The best method probably is to cut off and burn all the galls during the winter when they can be easily seen. This is a sure method of killing all the insects, and if all the galls are destroyed in a given locality, it should be very effective.

Willow Galls. *H. Osborn, Photo.*

The Yellow Spotted Willow Slug. Pteronus ventralis Say.

This is one of the worst pests of all kinds of willow excepting the weeping willow. Our attention was first drawn to these insects in the early spring soon after the young leaves are on the trees by the peculiar blister-like swellings seen upon the upper surface of the leave, which usually give them a wavy and crumpled appearance. The swellings are caused by the eggs being partly inserted into the leaf from the lower side. The adult female is provided with two saws under the posterior part of the abdomen, which are used to cut fine slits into the leaf. The under side of the leaf is probably always used for oviposition. Into these slits the long, oval, translucent green eggs are pushed and here increase greatly in size by absorbing the sap from the plant through their thin shells. This prevents their dislodgement before hatching. The writer collected a number of these eggs on May 3d on willows near the Olentangy river and the next day the young larvae were eating the leaves. Four to eight days are required for incubation, depending upon the temperature. When the larvae first appear they commence to eat small holes, which soon increase in size. The slugs born on the same leaf usually feed close together, but they cannot be called gregarious. When the larvae first leave the egg they are white with a small black spot on each side of the head. The black eyespots are plainly visible even through the egg shell. The white color soon disappears and later the slugs are shiny black, with transverse wrinkles and ten or twelve yellow spots on each side of the body along the stigmatal region. The yellow spots are prominent only after the last molt; but they are vaguely indicated in the younger stages, which are moreover usually marked by a narrow, yellow, longitudinal dorsal line. The head has a polished black color, and is as large as the first segment. The three pairs of true legs are long, black and pointed, the first pair being shortest and the third pair longest. Besides these there are six pairs of light blue prolegs and a seventh pair of imperfect anal ones. As the slugs grow in size they devour the whole leaf and soon denude the plant, leaving only the thicker portions of the midrib untouched. They make no attempt to hide in spite

of their conspicuous markings, but are plainly visible everywhere. They can always be distinguished by the peculiar curved position of the posterior segments, which often bend away from the true legs in the form of an interrogation point. They undergo four molts and reach maturity in from ten to twenty days. When full grown they are about twenty millimeters in length. They then leave the leaves and enter the ground, where they form shiny glue-like cocoons of dark bronze color. These cocoons have a rough outside layer enclosing a smooth and tough inner layer.

The adults are mostly black in color, but in the female the venter, tibiae, palpi and base of the wings are bluish-green, and the edges of the abdomen and bands between the segments are pale yellowish. The same parts in the male and the upper surface of the abdomen are yellowish-brown or orange colored. The females are rather sluggish and are not easily disturbed when engaged in sawing slits in the leaves for the reception of their eggs. The males are more active than the females, being one-third shorter and not so bulky. If not checked, six broods of this insect are possible in the central states.

Natural Enemies — According to Howard no parasite has yet been found to attack the larvae. The eggs are frequently destroyed by Chalcids of the genus Trichogramma, which become numerous when the second brood of female are ovipositing. The Wheel-bug (Prionidus cristatus) is of great service in reducing the numbers of these slugs. They destroy great numbers and are greatly to be desired for that reason.

Remedies — Where these slugs are very abundant probably the most satisfactory method of combating them would be to introduce a number of the Wheel-bugs mentioned above, as they would always be present to keep the slugs in check. Where this is impracticable, any of the arsenical poisons may be used and as this insect generally attacks the young plants, spraying can be made very effective with very little trouble. Spraying will also have the extra advantage of destroying any other foliage eating insects that may happen to be upon the plants at that time.

The Use of Colored Cloth in Shading Plants.

PROFESSOR WILLIAM R. LAZENBY.

At the first annual meeting of the Society for Horticultural Science, held in St. Louis, December 28th and 29th, 1903, the subject of shading plants and the physiological effects resulting therefrom were given much attention. If my memory serves me, one-half or more of the papers presented on that occasion treated of some phase of this general subject. Since then tests and experiments have been made by many station workers and these investigations are not only extending our knowledge but bid fair to improve our practice in the management of certain crops.

Light is one of the most essential elements in the growth of plants, and the relation of the plant to light is one of the most important of its life relations. Every intelligent grower of plants knows that excessive light is injurious, and that insufficient light is a most common cause of abnormal development.

The direct, unobstructed rays of the sun are at times especially inhospitable to plants recently transplanted, to young seedlings, unrooted cuttings, and various delicate foliaged shade loving species.

In studying the effects of shade on plants, it is extremely difficult to separate with any distinctness the influences of light and heat and moisture. The temperature is usually the highest where the sun's rays are brightest and least obstructed, at least there is such a close relationship between light and heat that the ordinary or average observer cannot confidently measure the effect of either independent of the other. Light and moisture (the water content of plants) are likewise closely related. It seems to be clearly demonstrated that bright or strong light stimulates transpiration and probably evaporation, independent of heat. Thus a plant may be exhausted of water in a low as well as higher temperature. To whatever causes the influences of shading may be ascribed in its last analysis, some of its effects can be foretold with reasonable certainty. Some artificial interferences with the

force of the solar rays, when used at the right time and place, are known to be beneficial, others are known to be injurious. In this, as with other ill-understood laws and principles, we should "prove all things and "hold fast to that which is good."

Among the various devices used to modify the force of the sun's light and heat, the ordinary white cheese cloth is by far the most common. During the present season the writer has made a few simple experiments or tests with colored cheese cloth or what is more popularly known as "bunting." In addition to the ordinary white or uncolored cloth, red, blue, yellow and black cloth of the same texture was tested. The cloth was used in two forms:

(1) Ten light frames, each two feet square, were made. These frames were completely covered over top and sides. They were divided into two sets, each set having the same five varieties or kind of cloth.

Under each of the first set of frames there were planted on May 1st, two each of cabbage and tomato plants and some seeds of corn and peas. Under each of the second set of frames there were planted two each of geranium and lettuce plants, and some seeds of beans and radishes. The lettuce, cabbage and tomato plants were selected from some thrifty seedlings that were about four weeks old. The geranuiums were from cuttings started the previous winter and kept in three-inch pots. When planted they were well budded and the main object in selecting them was to note the effect of the shading on the blooming, as well as on the general development of the plant. Care was taken to have all the plants of each kind used as nearly uniform in size, shape and vigor as possible, and the varieties selected were such as are considered standard in kitchen and market gardens.

The colored cloth was used in another form by stretching short lengths at various times over rows of seedlings and a few perennial plants like rhubarb, asparagus, etc. In this case, a single or double width of cloth was placed at various heights above the ground, ranging from six to eighteen inches, with the sides open. Of these latter tests, owing to lack of time, no systematic statistical records were kept.

The month of May last in Central Ohio was probably more favorable than the average May for testing the effects of shade on plants. A brief meteorological summary for the month is as follows:

The mean or average maximum was 83.5° F.

The mean or average minimum was 52° F.

And the general mean for the month was 62.8° F.

The highest temperature was 88 and the lowest 30°.

Ten days were clear, 13 partly cloudy and 9 were cloudy. Rain fell on 11 different days. The total precipitation of the month was 2.47 inches, nearly 1½ inches below the normal for May. From the 9th to the 22nd there was not the slightest trace of rain and of these twelve days eight were clear. From the first day of the month to the 22nd, the total precipitation was .76 inches.

This is not the time nor place for minute details of methods or records of the various tests. Some of the more evident results are as follows:

(1) The germination, or more properly the "coming up" of the planted seeds, especially the corn and beans, was hastened by the black cloth.

The seeds under the red came next in time, but considerably later than under the black shade, and not so uniformly in advance of the seeds under the blue, yellow and white cloth. With these three there was practically no difference in time of germination.

(2) After a few days the plants under the black and those under the red cloth began to show weakness and a comparative decline in rate of growth.

(3) A slight frost on the morning of May 7th quite seriously injured the tomatoes under the white and the blue cloth. Those under the yellow, the red and the black escaped injury, as did the same plants in the uncovered check plot. A hard frost on May 9th killed all of the tomato plants that were covered by the frames. Uncovered plants were nearly all killed, while those covered with cloth stretched a foot or more above the ground with the sides open were but slightly injured.

(4) The early shading of rhubarb with black cloth gave

excellent results in the way of lengthening the petiole and diminishing the size of the leaf blade. It also improved the quality by making the stems more crisp and tender. This latter effect was also observed in the shaded lettuce. The results with asparagus were not conclusive, and none of the shaded cabbage were as good as those uncovered. No good effects were seen in the early shading of tomatoes except their protection from frost and the same can be said of the sweet corn, if we except the hastening of germination.

(5) The geraniums bloomed earlier under the black cloth, but they soon had a somewhat unthrifty appearance and made less growth, and a considerable number of the leaves turned yellow.

The geraniums were more spindling or drawn under the blue than under any of the other colors. The same was true of the tomatoes.

(6) There was a greater range of temperature under the black cloth than under any of the others. The red showed the next greatest variation, then the yellow, blue and white.

With the exception of the black shade, the temperature was usually, but not always, lower than that in the mid-day sun outside. It was always higher under the black cloth.

(7) The plant lice were much worse on the shaded lettuce and cabbage than on the same plants outside. The shaded radishes and cabbages were free from the Anthomyian flies or root naggots.

While the observations made are slight and imperfect, they indicate that black bunting may be profitably used as a shade in early spring, and possibly at a later date on certain crops like celery, cauliflower, etc. It may also hasten the maturity of certain vegetables, like tomatoes, when used after the plant and fruit are well developed. Some of the colored shading material may be practically useful in protecting plants from frost, and from certain light-loving insects like the radish fly and the beetle.

A breeding place for mosquitoes at a city dump grounds.

Mosquitoes of Ohio.*

WM. E. EVANS, JR.

The importance of the mosquito problem only recently has been brought to the public attention. The insect has been with us for so long a time that some how it has come to be the feeling that there is nothing to do but bear with it; mitigate the nuisance whenever it is possible of course, but as to doing away with it in even large part, that seems to be looked upon as not worthy of consideration.

But it has been shown that the mosquito is not only a nuisance. It is a positive source of danger to health in the transfer of certain diseases.

Long before mosquitoes were thought to be agents in the spread of malaria and yellow fevers, they were considered as pests to man and beast. Every one knows what it is to try to sleep with one solitary mosquito humming around his head. The involuntary impulse is to smash it as soon as it alights. A single mosquito will usually awake a sound sleeper just by its peculiar song. The bite is not nearly so bad as the anticipation of getting bitten.

But how long have we gone on bearing these pests and how many supposedly intelligent people are still blaming Providence for creating such pests, when with a little co-operation with their neighbors they could successfully combat them at a minimum expense.

* Extracts from a thesis presented as part requirement for the degree of Bachelor of Science in Horticulture and Forestry at the Ohio State University in 1906. The work was carried on in the Department of Zoology and Entomology, part of it being done at the Lake Laboratory at Sandusky. Sixteen species of Mosquitoes were recorded from Ohio and conditions favorable to the production of these insects were studied in different localities. Much of what is given in this extract has been published in other places by various authors and is here presented with the hope that the members of the Society may gather from it some facts that will help them toward a better understanding of an important problem.

City people are not so greatly affected by mosquitoes as town and country people. But even in cities, especially in the suburbs, mosquitoes occur in vast numbers. I have never yet seen mosquito larvae in so great numbers as in the outskirts of Sanduksy at the city dump grounds.

LIFE HISTORY OF THE HOUSE MOSQUITO.

After a short period of love the female mosquito deposits her eggs upon the surface of the water, selecting for this purpose almost invariably the very early morning. Selecting a floating object or a quiet spot where the water is not much disturbed, the female deposits a large number of eggs in the shape of a raft. In doing so she supports her body upon the front four legs while the hind two legs are crossed. In the angle thus formed by the hind legs the eggs are formed into a sort of raft, as they pass over, one by one, from the ovipositor, and being sticky they adhere to one another. These small egg masses look like a bit of soot floating on the water and if examined closely it will be seen that each mass contains hundreds of eggs, and that each egg is a very elongated affair. Such egg masses which must float on the surface of the water to obtain the necessary air and warmth will always float in the proper position no matter how violently the water is agitated. To enable them to do so they are surrounded with a film of air.

In a few days (two to four under normal conditions) these eggs hatch and produce from the lower end the well known "wigglers." The name is well deserved on account of the wiggling motion of the larvae, which feed mainly below the surface of the water. The specific gravity of the larvae is greater than that of the water in which they move. If they move away from the surface film they invariably sink to the bottom. The larger larvae feed near the bottom and only come to the surface to get air. These larvae have a large head and thorax while the abdomen is more slender. The head, which usually points downward, possesses vibratile organs for sweeping minute particles of food into the mouth. The larvae possess a cylindrical breathing

tube at the end of the last segment. This tube is pushed above the water and the necessary supply of air is thus secured.

When the larva is full grown a remarkable change takes place, for a club-shaped pupa with an enlarged head and thorax is the result. The strange part of this wonderful change is the possession of two slender breathing tubes upon the back of the thorax instead of a single one in front of the tail. Though pupae do not require any food, they must be able to save themselves when disturbed and they sink from the surface the very minute the water becomes agitated, by a few strokes with paddle-like swimming organs situated at the tail. The trumpet shaped breathing tubes are lined with minute hairs which prevent the water from entering. Like the larvae, the pupae must come to the surface for air, but if not disturbed they always hang suspended from the surface film of water. In a few days the last transformation takes place. The pupa skin splits open on the back and the winged mosquito works its way very carefully out of the skin that covers its various members. As the wings are expanded and dry the insect flies away, now breathing air in the usual manner of insects by means of fine pairs of openings located in the sides of the thorax and abdomen. We have here the interesting fact that the same insect must breathe air in three different ways.

FOOD HABITS.

It has been conclusively proven that the adult mosquitoes subsist chiefly on vegetable juices. One author reports that, when he was sugaring for moths (a method often employed by entomologists to collect large numbers of owlet moths), the bait was frequently covered with mosquitoes all busily engaged in sucking the sweet material. But if opportunity offers, the females attack and suck the blood of all kinds of animals. Adult male mosquitoes do not necessarily take nourishment and the adult female does not necessarily rely upon the blood of warm-blooded animals for food. The mouth parts of the male are so different from those of the female that, if it feeds at all, it obtains its nourishment in a manner quite different from the female. Male mosquitoes have been observed sipping at drops of

water, and writers report that a fondness for molasses has been observed. They have also been known to sip at beer and wine. The female mosquitoes are without doubt plant feeders. It is generally supposed that a highly nutritive fluid is necessary for the formation of the eggs, but the supposition is emphatically denied by Dr. Howard. "There are in this country enormous tracts of marshy land into which warm-blooded animals never find their way, and in which mosquitoes are breeding in countless millions." Instances have been recorded in which mosquitoes have been observed feeding on boiled potatoes and watermelon rinds. That they occasionally feed upon other than warm-blooded animals has been proven conclusively. They have been observed feeding upon chrysalids of butterflies and puncturing the heads of young fishes.

MOSQUITOES AND DISEASES.

The mosquito is more than an irritating nuisance, keeping us screened and indoors on summer days and evenings when we should be enjoying beautiful America out of doors. But there is a much darker side to the question. There still exists in many parts of the United States, localities where quinine is a daily article of diet and where the recurrence of fever is as implicitly to be relied upon in most families as the rising and setting of the sun.

Yet this country is not the home of malaria; it abounds in Southern Europe, it extends across Southern Asia, it is found throughout the northern half of Australia, and in tropical regions it becomes pernicious and malignant. It is the cause of the jungle fevers as well as of the dreaded Cowan fever, and is not stamped out by moderately high altitudes but extends in a mild form far to the North, abounding in Holland and Belgium and even occurring in certain ill-favored spots in Sweden, Greenland and Siberia.

In temperate regions the mortality from malarial fevers is not high. Mr. L. O. Howard, in an article in Century, Vol. 39, page 941, gives the following figures:

"In 1860 in the United States, malarial fevers caused 3,976 out of every 100,000 deaths from all causes. In 1880 the proportion was 2,673 per 100,000. It is known that from 1887 to 1897 the average annual death in Italy from malaria was 15,000, while in 1892 5,000,000 deaths in India were ascribed to 'fever' and a high percentage of these fevers were malarial. But the death rate from malaria is only a faint expression of the trouble and misery caused by these diseases. The number of people incapacitated from work from this cause, if there were any reliable way to estimate it, would unquestionably be startling. Nearly one-third of the British Army in India in 1897 according to Ross were treated in hospitals for malaria, while it is estimated that in Italy, two millions suffer annually from this cause."

How often is the following sentence seen in advertisements of summer resort hotels: "The region in which the hotel is situated is free from malaria and mosquitoes." In the minds of the advertisers there is not an inkling of connection between malaria and mosquitoes, yet how naturally are these two words linked together.

It has been common knowledge that if one goes within doors at early dusk and remains there until broad day light, one is not apt to take chills and fever. In common with this we know that mosquitoes fly and inflict their bites mostly between late afternoon and early morning. It has been noticed that malaria is most prevalent in damp swampy regions; it is also known that these regions are the homes of mosquitoes, so that it seems very easy to connect the two. It is remarkable that with all this circumstantial evidence, more people did not become suspicious of mosquitoes long ago, but it was not until the year 1882 that the idea that the mosquito was responsible for the transfer of the malarial germs from an infected person to a healthy person was forcibly brought before the mind of the people. But little notice was taken of it even then and it failed to come before the public in a convincing manner until the summer of 1900. Then it was that the Italian, Grossi, demonstrated by actual experiment, that if people protected themselves against the bites of certain mosquitoes they could live free from malaria. Again during the late summer and autumn of 1900 two English phy-

sicians, Sanbon and Low, lived in a house standing in one of the most malarial districts of Campagna. The house was thoroughly screened. The men during their entire stay were free from malaria, while the natives living in unprotected houses suffered greatly from chills and fever. At the same time an Anopheles mosquito that had bitten a malarial patient was sent to England and there allowed to bite a perfectly healthy person who had never had the disease, at least not since early childhood, and in due time this person contracted a genuine case of malaria. All these cases ought to make it clear to any one that without mosquitoes we would be free from malaria.

The recent outbreaks of yellow fever in the South warrants some attention, and the following experiments make conclusive the relation between yellow fever and a certain species of mosquito.

In a field near Suemodos, Cuba, a commission of surgeons erected a small wooden building tightly ceiled, and with the windows and doors closely screened. In this house for a total of sixty -three days, seven non-immune men were kept. They used the non-washed pillow slips, sheets and blankets that had previously been used by genuine yellow fever patients at Havana. Neither during their stay or afterward did these men develop yellow fever. So it was clearly proven that yellow fever is not carried in clothing.

They tried another experiment. They erected another building and carefully divided it with wire screen into two parts. All the windows, doors, etc., were carefully screened so as to permit the entrance of no mosquitoes from the outside. In one of the rooms mosquitoes of a certain kind, known to have previously bitten patients with yellow fever were placed. In the other rooms no mosquitoes were placed. All the bed clothing, etc., was carefully disinfected before using. Non-immune men were placed in both rooms.

Of those in the room containing no mosquitoes, all were free from the fever, but six out of the seven men placed in the room containing mosquitoes, developed genuine cases of yellow fever. This is surely good evidence to prove that without mos-

quitoes of a certain kind yellow fever is impossible. But since this mosquito does not occur in Ohio no lengthy discussion is necessary.

Dr. L. O. Howard describes the transmission of malaria fever as follows, in the Review of Reviews, Vol. 24, page 192: "All of the malarial parasites are protozoans; that is to say, animals and not bacteria.

In the human blood these protozoa inhabit the red blood corpuscles and in the blood they go through a sporulating existence, which may continue indefinitely unless checked by quinine or some other way.

In the red corpuscle the parasite appears as an amoebula, which gradually grows until it nearly fills the interior of the corpuscle, digesting apparently the coloring matter of the blood and forming as the result of this digestion, pigment spots in its interior.

On reaching full growth the nucleus of the amoebula subdivides, each division gathering about itself a certain amount of protoplasm, until, instead of the single amoebula, the corpuscle contains a large number of spores. The walls of the corpuscle then break and the spores are liberated into the blood serum. From a single infection sporulation or liberation of the spores takes place practically simultaneously and marks the beginning of the malarial spasm.

The three different kinds of malaria, namely, that in which the fever recurs every two days, known as tertian malaria; that in which the fever recurs every three days, known as quartian fever, and the seruse autumn fever known as aestivo-autumnal fever or tropical malaria — by far the most dangerous of the three — are all supposed by some writers to be caused by distinct parasites. This view is not held by all writers. But at all events the period of development of the sporulating stage of the organism differs in length of time. As is well known, it frequently happens that the malarial fever or chill will occur every day. That means in tertian malaria that there has been a reinfection on one of the alternating days, the development of the

amoebulas being constant in point of time, one set sporulating twenty hours after the other set.

It is just as this sporulation occurs, just as the spores are liberated into the blood serum, just as the malarial spasm is about to begin, that the administration of quinine is most effective.

It seems to kill the spores when they are liberated, but it appears to have very slight effect upon the organism when it is enveloped in the blood corpuscle.

In this sporulating development each of the liberated spores attack and enter new red corpuscles. Many continue, as above stated, indefinitely. But not all of the amoebulas undergo this development. Some of them so long as they remain in the human blood apparently die and are digested by the leucocytes.

When, however, these forms are taken from the blood, even when the blood sample is simply placed under the microscope for examination, they undergo a development entirely different from the sporulating form. Some of them grow large. Others put out slender filamentary arms, or flagella, as they are called, which separate from the body of the organism and fuse with those which do not flagellate.

This is the true sexual generation of the parasite, the flagellating form representing the male sex and the receptive forms the female sex. The development up to this point will take place anywhere outside the human body, in the stomach of the mosquito of the Genus Culex or presumably of other biting insects, but it is only in the stomachs of the Genus Anopheles, so far as observed, that a further development takes place.

After a fusing of the flagella with the female germs in the stomach of the Anopheles mosquito the fertilized organisms attach themselves to the walls of the stomach, penetrate the inner walls and locate themselves just under the outer muscular wall. They rapidly increase in size until they eventually become five times as large as at first. They are now known as zygotes. Clear spaces begin to appear on the surface.

These clear spaces are known as centromeres, and are rapidly surrounded by minute, short, dark lines which, when seen

under a very high power microscope, are shown to be spindle shaped cells, known as blasts. These blasts rapidly increase in number until eventually they fill the entire zygote, obscuring the centromeres, and when this condition of affairs is reached the zygote bursts and the blasts are liberated through the muscular wall of the stomach into the body cavity of the mosquito. They are active and penetrate rapidly into the tissue of the salivary duct and so into the proboscis of the mosquito, and with the saliva or poison they enter the blood of the next warm-blooded animal which the mosquito bites.

It is supposed that the blasts enter the red blood corpuscles and the development re-begins at the stage where we took it up."

It is thus shown that the full development of the malarial parasite cannot take place within the human body; that the Anopheles mosquitoes are necessary secondary hosts; that the sexual generation of the parasite takes place only in the mosquito of the Genus Anopheles and further that the old idea of malaria from bad air, swamp, "miasma" and so on are, to the minds of those familiar with the subject of the biology of these low forms of life, completely overturned.

REMEDIES.

As a mosquito bite exercises quite a different effect upon different persons, the matter of counter irritants or applications to allay the pain are somewhat individual.

For most persons the application of a drop of ammonia water used directly after the bite will allay the pain. Eucalyptal, menthol, etc., act well for some persons.

REPELLANTS.

Oil of citronella is perhaps the cleanest and most effective repellant; the odor is not unpleasant, it is quite lasting, and lastly it keeps off the mosquitoes. It may be applied to the hands and face, but must be kept out of the eyes. The citronella is an extract from a grass, Andropogan nardus, and is used chiefly in the manufacture of the cheaper grades of perfumery.

Painting a screen lightly with a brush dipped in kerosene will put a stop to mosquitoes working their way through the wire netting screens.

DESTRUCTIVE MEASURES.

Early in spring when all plants are in the bonds of winter, no insects can be discovered by those whose eyes are not trained for seeing such things. Yet a close and trained observer can readily discover in sheltered nooks and corners in cellars, stables, under stones, boards, trash, etc., a large number of insects that have found winter quarters in such places.

In this manner winters the mosquito; but in this state we cannot combat the mosquito problem. We must wait until the eggs are laid and the larvae begins to appear before we can hope to combat the insect very successfully.

The best method yet discovered is to cover the water surface with a thin film of kerosene.

Regions in which stagnant water abounds are famous or rather infamous on account of the vast numbers of such insects and their presence is easily accounted for. It is assuredly not a good thing to breed mosquitoes near our houses. To prevent them from breeding it is necessary to destroy them, and the easiest way yet discovered is to shut them off from a supply of air. Many trials have shown that by pouring just a little oil on the surface of the water, so as to form a very thin film, that all mosquitoes will be exterminated in the place treated. The work must be done intelligently; the treatment of running streams or bodies in which fish, frogs, or other aquatic animals live or can be made to live is unnecessary and even in some cases absurd, particularly if the agent employed is destructive to the fish, for their natural checks are destroyed, and any lapse or defect in the artificial treatment will result in greater trouble than ever.

The rational method is to assist the natural checks so far as may be and employ destructive agents only when permanent works fail to give relief. For instance, it will pay better to fill a depression in which rain water habitually accumulates with a load of sand, than to treat it with oil every two weeks during

the summer, and it will pay better to stock a pond with proper fish, and trim the banks, than to spray periodically with oils.

The usual manner is to spray the kerosene so that a very fine film covers the surface. The oil is usually applied with a sprayer, and to be effective every portion of the place to be sprayed must be covered. Experiments show that about one ounce to every fifteen square feet is about right. This should be repeated as often as necessary. The time will vary according to the conditions. If the wind blows all the oil to one end of the pond it will be absorbed by the soil and lost. A photograph shown in this paper was taken at Sandusky, Ohio, at the city dump grounds. This was formerly the location of stone quarries and the old excavations have become filled with water which has become very stagnant and foul, and on my visits there last summer, I found larvae and pupae of Culex pipiens in countless millions. It would be impossible to drain these ponds without considerable expense because of the blasting that would be necessary. The water is too foul for fish or other forms of aquatic life, but spraying could be carried on very easily. With a little work the banks could be trimmed up, the old boxes, barrels, cans, etc., taken out of the water and the place sprayed.

The one pond is about two hundred by twenty feet, and with a little kerosene, a spray pump, and a little labor, millions of these pests could be destroyed, and the neighborhood made inhabitable.

I noticed that the larvae and pupae would gather along the edges of the bank, or obstacles in the water, in great masses; very few were noticed in the open water. With one dip of the "coffee-strainer," three inches in diameter, I could secure thousands of the larvae and pupae. I have never seen larvae in such numbers.

No fish were observed in these waters, but the larvae of many water beetles, prominent among which were Hydrophilus, the larvae of which were very busily feeding on the larvae of the mosquito. This I ascertained by dissection.

The Sand Pipers were very valuable in controlling the pests, for these birds are very plentiful in this region particularly, and

seemed very busy feeding on the adult mosquitoes and no doubt greatly reducing their numbers.

But we do not need to go to Sandusky to see these ponds, for right on our campus, back of the Biological Hall, is a little pond which in summer time contains many mosquito larvae. This pond could very easily be drained, the drains emptying into "Mirror Lake." The water is too shallow for fish, and there is too much of a general depression to fill up, and it would not be economical to spray when so permanent a preventative as drainage could be applied.

Among the fishes, the top minnows are considered the very best for destroying the larvae. They swim near the surface and very readily feed on the mosquitoes. These minnows can be obtained easily by seining small streams and transferring them to the place desired.

Mr. J. B. Smith reports the very interesting investigation on the influence of the internal parasitic worm, Agamomermis culicis. The curious fact developed that at one period fully eighty per cent. of the examined mosquitoes were wormy and that at least one of the broods was materially reduced by the parasite.

Mr. R. H. Pettit, in Michigan Bulletin, No. 204, page 15, reports that the fungus Entomophthora is very instrumental in reducing the mosquito in some localities. The infested mosquitoes were very numerous on the margins of pools, and the surface of the ground in the surrounding woods of the locality examined.

Mosquitoes are very frequently infested with mites. While collecting at Cedar Point, I caught several species of Taeniorhynchus perturbans Walk, which had a least a dozen of these mites fastened to the neck of the mosquito. These mites surely will reduce the number of the mosquitoes if they occur in large enough numbers. The mites were identified by Prof. Osborn as belonging to the Family Trombididae.

POINTS TO BE REMEMBERED BY THE HOUSEKEEPER.

All mosquitoes breed in stagnant water.

From seven to twenty-four days are required to produce a brood, of a hundred fold or more, from eggs to winged insects.

A mosquito a day old is full grown.

Most kinds breed within a very short distance of the scene of their biting activities, frequently within the house itself.

The Malarial mosquitoes, Anopheles, are the most dangerous domestic mosquitoes, and breed in a little puddle or receptacle of water that stands for a week or two.

Some of them will bite in the day time.

The common house mosquitoes, and among them are the malarial carriers, are among the most abundant and they enter houses to breed if possible.

They hibernate in the cellar over winter, ready to breed in the first spoonful of available water, in April or May.

Therefore most of the trouble is from "skeeters" that breed close to our houses and therefore often within our own control.

If carefully done one season's effort will almost entirely rid a neighborhood of mosquitoes and make easier work for the next year.

Once you rid your own place of receptacles that hold stagnant water, and you still have mosquitoes, be sure that your neighbor has not done as you have done. Get him to follow your example, and then look around the neighborhood for a swamp, a sluggish brook, or a pond. These suspicious places may be treated with the kerosene, which must be applied so that the entire surface is covered with an oil film. When the film is broken the protection is insufficient, as any opening will allow the larvae to breathe. A common watering pot with a fine "nose" will answer the purpose. Gold fish or top minnows should be added to the fountains. These fish are voracious eaters of mosquito larvae. But one thing must be remembered: do not put kerosene on water that has fish in it. Use one or the other, not both at the same time.

If you are troubled with mosquitoes remember that some-

where within about eight hundred yards of your house you will find the female mosquito laying her eggs in a cesspool, watering pan for birds, a garden fountain, a hole in a tree, a water receptacle for a grind stone, a watering pan for a dog, cat or chickens, a broken piece of crockery that holds water, an old tin can, an empty bottle, a roof gutter that is clogged, a horse trough, a rain barrel, a sewer inlet, etc., etc.

In fact mosquitoes are apt to breed in any water that stands a few days. One tomato can in a shady place may breed enough mosquitoes to keep a family unhappy for the entire summer.

If the rain barrel has wigglers in it, either screen the top, or pour a little kerosene on the top and then draw the water from below the surface. This method will destroy all "wigglers" and not injure the water. The same methods should be applied to the rain water cisterns. All vaults in the city back yards should have a little kerosene every few weeks.

Keep the house well screened, and be sure that you do not breed mosquitoes in your house in the dish under the flower pot, in the vessel for cut flowers, in the fernery on the table, or in the different vessels placed on the top of the clock, etc., "to keep the furniture from drying out" as the housewife says. All these simple rules are worth remembering.

Some Principles Relative to Tree Planting.

ROBERT A. YOUNG.

The purpose of this paper is to state some of the principles that must underlie successful tree planting. No attempt is made to lay down rules, though if the principles be accepted, some few rules will be obvious.

First, I wish to speak of the distribution of trees. The distribution at large is determined mainly by atmospheric factors, as extremes of temperature, average temperature during the

growing season, and moisture. To make this point clearer: the fir and spruce zones of Europe, Asia and America are determined by lines within which the average summer temperature is between 53° and 59° F.

The local distribution of trees is affected largely by slope and exposure, by soil factors, as soil-heat, soil-air, and soil-moisture, and the chemical and physical constitution of the soil. Soil conditions are determined chiefly by topography, drainage being perhaps most largely affected by this cause.

The water content seems to be the principle soil factor in influencing the local distribution of trees, as well as most other plants; but that this is not the only factor may be shown by one or two examples.

The peat bog and the heath differ very greatly in water content, and yet the plants growing in these places are quite closely related, and those in the peat bog frequently bear leathery or hairy leaves and special organs for absorption, such as are characteristic of plants in rather dry situations. Again, the peat bog and river swamp have similar water contents, but the vegetation is radically different. In the character of the soil of the peat bog is probably to be found the explanation for these two cases.

Nearly every plant will thrive best under certain conditions, and it should be the aim in planting trees to meet as nearly as possible the conditions under which a tree grows best in its wild state.

Some trees, as the silver maple, boxelder, and honey-locust, adapt themselves very well to a great variety of conditions, from very moist to very dry, but most trees are a little more exacting, and many will stand but little change from an optimum environment.

Willows are at home by the side of a stream and can not be expected to do well in a very different habitat. The cottonwood does best in somewhat similar conditions, but with soil not too wet or heavy. It will not live long in dry upland soils.

In Kansas where I had opportunity to observe, the white elm

thrives near stream margins and in bottoms of moist ravines, but higher up the trees do not do well.

The hackberry establishes itself under slightly drier conditions than the elm chooses.

In the West the ash has generally adapted itself pretty well to rather dry uplands, though it, as nearly all other trees of central and eastern United States, prefers somewhat moist locations.

The black locust succeeds well under conditions of scant moisture.

The sycamore, as we see from the conditions in the vicinity of Columbus, is essentially a river bank or low flood-plain tree, though it will grow in less moist locations if it gets a start. The buckeye has similar requirements. It is to be found around Columbus, mostly near the river bank.

The sugar and black maples will not endure dryness, nor are they found in very wet soil.

The black walnut seems to do well in almost any rich soil.

The catalpa grows under many different conditions, but for its best development, the soil must be rich and moist. This tree is a striking example of those that do indifferently in unfavorable environment but respond admirably to favorable conditions.

Horticulture in the Hawaiian Islands.

OTTO H. SWEZEY.

It may be said that Horticulture has not yet advanced beyond its infancy in this group of islands. Although this group is favored by a sub-tropical climate, and a great number of tropical and sub-tropical fruits may be grown, and are grown more or less, yet very few of them are grown in a systematic or scientific way, or on a commercial scale. An important reason for this is that the growing of sugar cane is the main industry of the islands, and practically all of the available, arable land suitably

located for transportation facilities has been taken under control by the sugar plantations, so that the prospects of embarking extensively into fruit-raising should there be anyone so inclined. have been very discouraging.

Within a few years, however, some tracts of hitherto unoccupied lands have been made accessible and proven adaptable in some instances to growing certain kinds of fruit. The United States Agricultural Experiment Station in Honolulu has been engaged in investigations to determine what fruits may be grown profitably, and on best methods of culture, also on experiments towards improved methods of shipping. Considerable capital has been diverted to fruit raising, and at present the future prospects for Horticulture in Hawaii are quite encouraging. Already there has been considerable exportation of bananas and pineapples, the shipments of the latter fruit especially being on a rapid increase. The amount of the other kinds of fruit grown has not been beyond what was needed for home consumption. In fact, for most kinds of fruit that readily thrive here, the amount grown falls far short of supplying the home markets. It is often difficult from the markets to obtain the more common or these, and even then one has usually to accept inferior quality. Many of the valuable tropical fruits can only rarely be obtained from the markets, or not at all unless one is fortunate enough to have the acquaintance of some one who grows these fruits merely for supplying their own tables. There is always a supply of fruit to be obtained, however, at Honolulu. Fruit stalls are very numerous and usually run by Chinese or Japanese; but the fruit they have displayed in pyramids and boxes is more often supplied from the orchards of California and Oregon, oranges and apples predominating. There are times, however, when such fruit as papaias, mangoes, avocado pears and pineapples are in season that these too are prominent upon the fruit stands. But the visitors and tourists here often inquire, "Where are your native fruits?" and complain at not finding them at the hotels. There certainly is much room for the development of Horticulture in these islands. For the sake of convenience each kind of fruit will be treated of separately in this paper.

PINEAPPLES.

At present pineapples are raised more ostensibly for export than any other fruit. They are mostly shipped canned. It is said that canned pineapples were exported to the United States before the annexation of Hawaii; since that event the pineapple industry has been having a continually increasing growth, and now there are several districts on the different islands where there is a considerable acreage of pineapples. The pineapple plantations are mostly owned and operated by stock companies. In one instance one company has a plantation of 1,000 acres.

There are also numerous small private plantations of pineapples in the vicinity of the larger ones. In one district the contiguous plantations comprise about 3,000 acres. The companies have canneries and the largest part of the crop is put onto the market in tin cans and glass jars. The smaller growers sell their fruit to the canneries. The last two years have witnessed an exceedingly rapid increase in the acreage of pineapples, and it is estimated that this year the export of canned pineapples will reach the amount of $700,000. Not all are shipped in cans; but a considerable quantity goes as fresh fruit to California and the other coast states. They have even been satisfactorily shipped to the Denver markets. Already the export of canned pineapples forms the second largest export of these islands; being surpassed only by sugar, which is about $30,000,000 annually. A large quantity is disposed of by the local markets besides.

The pineapple districts lie at an elevation of from a few hundred to 1,000 feet, or more, and usually where there is sufficient rainfall so that it is not necessary to irrigate, and as they thrive with less rainfall than sugar cane, there are tracts where through too small a rainfall or impossibility of irrigation sugar cane cannot be grown, but the conditions favor the growth of pineapples. These facts have recently become more thoroughly known and hence the recent rapid growth of this new industry.

The plants are propagated by suckers. These are set in rows about four feet apart, and about two feet apart in the row (these distances vary with the character of soil, the district, individual opinion, etc.) In some districts if planted the same distance

apart as would be proper in other districts the pines might be either too small or too large to fit the cans used; hence the proper distance apart for planting has to be determined for each individual district, if the pines are to be canned. If they are to go on the market fresh, other considerations determine the distance apart, convenience of cultivation, etc. The number per acre ranges from 5,000 to 9,000. It takes about 18 months from planting till a crop is ready to harvest. Suckers from the old plant may be allowed to grow after the crop is harvested, and thus a second crop (rattoons) secured, and even a third similarly without replanting the field.

A good crop is 8 to 10 tons of fruit per acre; and this is worth $30 to $35 per ton at the cannery. From this it is seen that a crop amounts to from $240 to $350 per acre, which is very profitable, even though the land costs from $200 to $500 per acre.

The quality of the Hawaiian pineapples is unsurpassed. They are canned in their own juices with only the addition of sugar. As they are allowed to become fully ripe before harvesting, and are not shipped long distances before canning, further accounts for the superiority of Hawaiian canned pineapples over others in the American markets, which have been harvested green and shipped long distances before being canned.

BANANAS.

The banana is second in importance of the fruits grown here, and it is only a very few years that the shipments of pineapples have surpassed those of bananas. Considerable shipping of bananas took place long before the pineapple industry had become of importance. There are many places on the islands very well adapted for growing bananas, both as regards climate and sufficient rainfall. That this is the proper climate for bananas is evidenced by the fact that they grow wild in many gulches of the mountains.

There are numerous varieties grown in small quantities for home-supply and sometimes finding their way to the local markets: viz., apple-banana, Brazilian, Red Spanish, Largo, and

plantains or cooking bananas, besides several native varieties. Nearly every one has bananas planted on his grounds, both for shade and ornament as well as for fruit. None of the above mentioned are raised in sufficient numbers for shipment, nor do they reach the local markets in large quantities.

The Chinese variety, or species (*Musa cavendishi*) is the kind grown for shipment to the mainland markets. There are many plantations of them of varying sizes, but usually of not nearly the area of the pineapple plantations. They are mostly located on low lands near shore or in valleys between mountain ridges where they are limited in extent by the size of the valleys. In some lowlands near Honolulu (formerly marshes) they are grown on ridges of earth thrown up so as to be but a foot or two above the water, thus they get the requisite amount of water even though located in a region where there is very little rainfall. Up the valleys the rainfall is sufficient for their needs.

The Chinese banana matures a bunch of fruit in about one year from planting, in the meantime a new sucker has grown to produce another bunch the following year; thus one bunch per year indefinitely. This variety grows to a much less height than the others, about 4 to 6 feet to the bunch of fruit, which is quite an advantage in harvesting and also makes them less liable to damage by the wind. They are planted at varying distances apart, according to the character of the soil, the amount of moisture available, and the opinions of the different planters. This distance may be as close as 6 feet by 6 feet, or as great as 10 feet by 12 feet. According to the distance apart planted, the number per acre varies from 300 to 1,200, and thus the yield per acre is evident — probably about 750 bunches being a good average. The prices range very low, however, so that profits are not unusually great; if the planter gets 20 to 25 cents per bunch it is as good as he can expect. The banana planters are mostly Chinese and Japanese.

The Chinese banana has an excellent flavor and is fine eating when allowed to ripen before gathering; but the main objection to this variety for shipping is that the skins of the bananas are easily bruised, and then they turn black, and they also are apt

to blacken in ripening by the time they are in proper condition to eat; the final stage of ripening is also very rapid, so that they must be disposed of at once when the proper time comes. Furthermore, the steamship lines have made no special provision for carrying bananas. The individual bunches wrapped in dead banana leaves are piled up on deck. They are often spoiled when they reach the coast markets, and hence there has been great loss in shipping, and consequent discouragement to the banana industry. The freight rates have been so high, also, that many planters have abandoned banana growing.

On account of the Chinese bananas being so poorly adapted to shipping to a distant market, the "Bluefield" or Jamaica banana has been introduced recently. The U. S. Experiment Station obtained a few plants in 1903, which have been propagated until there have been quite a good many plants distributed to the various parts of the islands. It may be expected that there will be shipments of these in good quantities soon; and that they will prove much superior to the Chinese banana for shipping from Hawaii, and that they will bring a renewed activity to the banana industry. The export of bananas began with less than 100 bunches in 1864. It increased to 126,000 bunches in 1896.

PAPAIAS. (Pronounced *Pä-pī-yäs.*)

This tropical fruit is very highly prized here. Unfortunately it does not bear shipment, so it never reaches the cities of temperate latitudes. Some shipments have been made from Honolulu to the coast States, however, with good success, and probably with proper packing and handling somewhat of a trade may be worked up in the future. This fruit thrives very readily here, and quantities are grown and eaten. The trees usually ripen fruit within about a year of planting. All gardens have a few papaia trees, and there are enough small orchards scattered in favorable locations which supply the local markets nearly the year round. In some places they often have a surplus, which is then fed to the pigs and chickens.

In orchards they are usually about 6 feet apart, but when planted, many more plants are set than are required, for the

tree is dioecius and only an occasional tree bearing male flowers is required. As the trees are grown from the seed, the sex of the tree cannot be determined until they are old enough to blossom, when most of the male trees are removed. The trees bear well for two or three years, when they need to be removed. They rapidly exhaust the soil.

The fruit is oblong and from 6 to 12 inches long. It somewhat resembles a canteloupe and is eaten in the same way. The tree has a simple straight trunk with numerous large much divided leaves on long petioles, and the blossoms are in the axils of these, and hence the growing fruits are very closely packed on short pedicels all along the upper part of the trunk of the tree.

CITRUS FRUITS.

Oranges, lemons, limes and pomelos all do well here, and yield delicious fruit when given proper attention; but they grow so easily that they are usually neglected and there is very little effort to grow any of them commercially. Nearly every one in Honolulu plants orange and lime trees on their grounds, but they are usually left unpruned and no attention given except to provide them with water. Only a few efforts have been made to grow the navel oranges and other seedless varieties; but those which are grown are very juicy, and of a fine flavor and many prefer them to the California fruit in spite of the fact that they are generously supplied with seeds. In some districts sufficient oranges are grown to furnish some for the local markets; for instance, the steamers coming, from the island of Hawaii sometimes bring 10 to 30 barrels of oranges for the Honolulu markets. They are somewhat cheaper than the California oranges in the retail shops, often running as low as 15 cents per dozen. What are grown in the islands do not begin to supply the markets, however. At present $100,000 worth of citrus fruits are imported from California per year. There is no reason why the islands should not produce all the oranges and other citrus fruits that are consumed here. It is probable that more may be done in that line in the future. The U. S. Experiment Station has issued a Bulletin on the culture of citrus fruits here, and setting forth

the practicability of attempts being made to supply our own markets, which will serve a needed stimulus in that direction. The Station has issued valuable Bulletins on the culture of many of the other fruits also.

AVOCADO PEAR.

This is a pear shaped fruit 4 to 6 inches long, having a large seed in the center. It is a delicious fruit, but usually not relished at first. One has to acquire a taste for it. They grow on large trees, 20 to 40 feet tall, but they usually begin bearing when much smaller — about 4 years old. This, like so many fruits, is not grown particularly for market, but people have a few trees for their own use; and when they bear well there is usually a surplus to go to market. The season for ripe fruit is about May to September and during this time they may be found in the fruit stalls in limited quantities, at prices ranging from 5 to 15 cents per fruit, according to quality and abundance.

Small shipments of these pears are sometimes made to the coast cities, and probably if given more attention a good trade could be worked up in seasons when pears are plentiful.

MANGOES.

Another fruit which grows on large trees (40-50 feet tall) and often requires an acquired taste to relish them. The inferior varieties have a more or less turpentine flavor and too fibrous a texture. The trees grow so readily from the seed and thrive with so little attention, that every one has a few trees and great quantities of the fruit are eaten during their sason, which is usually from April to September, or often a longer period. During this time they are usually plentiful in the Honolulu fruit stalls, but unfortunately mostly of poor quality. Until recently no attention has been given to propagating the better varieties and whatever of these there may be are not in sufficient quantity to find their way into the markets. In fact those who have been most interested in grafting and propagating the better varieties, and also importing superior varieties from other places, have been people of means who were not growing fruit for market

but rather for their own tables; and any surplus is more likely to be given away to friends.

With a general awakening in horticultural lines there is no doubt that much improvement will result in the varieties of mangoes grown and the quality of the fruit found in the local markets. It has been demonstrated that the fruit if picked at the proper degree of maturity and properly handled and packed, may be shipped for long distances, and it is hoped that with the growing of better mangoes here, an export trade may be worked up with the coast cities of the United States. Recently there has been started a jam and jelly factory which supplies the local markets and also an increasing shipping market with mango-chutney.

GRAPES.

Grapes thrive well when properly taken care of. They are mostly grown by the Portuguese, the trellis method being used. Not a sufficient number are grown, however, to supply the local markets. They sell at about 10 to 15 cents per pound. The chief variety grown is the Isabella. Occasionally a few Tokays may be seen in the markets. By far the larger proportion of grapes in the markets are imported from California. In places remote from Honolulu some wine is produced.

FIGS.

This is another fruit grown mostly for market by the Portuguese, but many others have them in their gardens as well. Some very delicious varieties are grown; but the markets are never very well supplied with them. No one grows them in quantities — never more than a few trees. They are always eaten fresh. Quite recently one gardener has made the attempt to introduce the Smyrna fig from California, together with its associated insects necessary for the proper polination of its flowers and production of fruit. If this proves successful here there is no reason why there cannot be a fig packing industry started here, the same as in California since the introduction of the Smyrna fig insects there. Our dealers import a considerable

quantity of California figs, both the "Calimyrna," as they are called, as well as the common ones. There would need to be considerable increase in the amount of figs grown here before our markets would be supplied with importing.

STRAWBERRIES.

During the winter season, about December to March, the strawberry is to be obtained in small quantities from the markets, and at high prices, about 25 cents per quart. They are usually not sold by the quart, however, but in small tin cans, of which it takes about six to make a quart. These are grown mostly by Chinese in some of the adjacent valleys and at a higher level, where there is greater rainfall. Very inferior varieties are grown, and not very modern methods of cultivation used. Recently, however, some white homesteaders have been growing some excellent berries on a high plateau in the middle of the island. Their product goes chiefly to the large hotels. Only a few acres are being grown at present. Probably as they are found to grow satisfactorily more will be planted, and in the coming years the strawberry may be more abundant in our markets.

ROSELLE.

This is a fruit recently grown in an experimental way by the U. S. Experiment Station. A successful crop was grown last year and the seeds distributed throughout the islands to those interested. It is a low, much branched shrubby plant, and bears numerous large blossoms resembling the Hibiscus to which it is near related. The calyx of the flower becomes fleshy and ripens with the fruit, which is bright red. These when stewed or made into jelly make an excellent substitute for cranberry sauce and jelly.

PEACHES.

This fruit does not do well here although a few are grown in the gardens of Honolulu and in the homestead districts of the islands. Apparently the trees make too much of a growth, and as they grow the year round and are never pruned not much is

to be expected in the way of fruit; but occasionally some fair samples are seen.

APPLES.

Apples grow even less satisfactory than peaches. The entire supply of apples comes from California, Oregon and Washington. Many thousands of dollar's worth are consumed annually. They are shipped in boxes holding a little less than a bushel, wrapped in paper the same as oranges, and the price to consumers is usually $2.00 to $2.50 per box.

MISCELLANEOUS TROPICAL FRUITS.

There are a large number of tropical fruits of which only a few are grown on private grounds, and never in large enough quantities for market. Many of them thrive well and might with proper attention be grown on a commercial scale, at least for the local markets. Among these may be mentioned Bread-fruit, Vi, Soursop, Pomegranate, Date, Java plum, Loquat, Star apple, Carambola, Sapodilla, etc. The guava has run wild in uncultivated tracts of the valleys and lower ridges, and the fruit is much gathered for jam and jelly, considerable of which is found in the local markets; small quantities are also shipped.

It will be seen that at present the only fruits grown in the Hawaiian Islands to any extent from the commercial point of view are the Pineapples and Bananas. Numerous other fruits will grow satisfactorily here, but cannot be grown on a large scale, either on account of the fact that the arable land is chiefly devoted to sugar cane; or on account of the nature of the fruit, being unadapted to shipping long distances, or again on account of shipping rates being too high. Since the growing of pineapples has been found so successful and profitable in recent years, there is likely to be a more active interest taken in cultivation of other fruits, many of which the U. S. Agricultural Experiment Station here has demonstrated can be grown more satisfactorily than they are at present.

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